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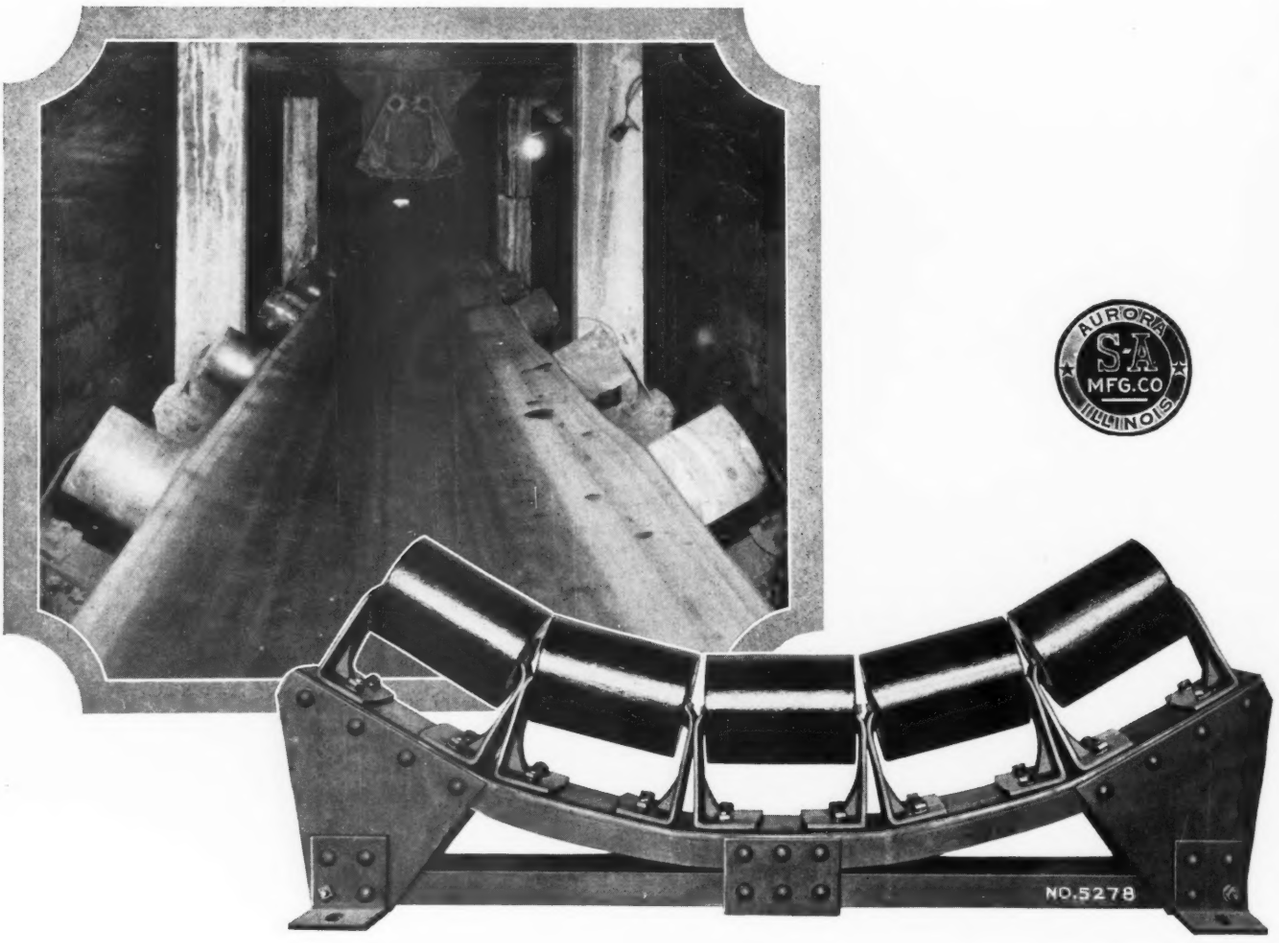
A WEEKLY JOURNAL REPRESENTING THE WORLD'S MINING AND METAL INDUSTRIES

March 24, 1923



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The First Step

CONGRESS has adjourned not to reconvene until next December. The last few days of Congressional business were crowded with activity. Haste and procrastination, delight and disappointment, held sway alternately. One of the last bits of legislation rushed through the Senate, and one of great moment to gold and silver miners, was the resolution of Senator Walsh, of Montana, providing for a Senate committee to look into the gold and silver situation. An attempt was made to establish a joint commission of investigation drawn from both houses, but it failed to receive consideration in the congestion prevailing in the lower house. Realizing that delay would be calamitous, so far as active governmental aid to the gold and silver miners was concerned, Senator Walsh persuaded his colleagues to pass a resolution calling solely for a Senate committee. His resolution carried and became law.

And so the first step has been taken to try to secure governmental help for the precious-metal miners. During the coming months Senators Nicholson, Oddie, Gooding, Pittman, and Walsh, who comprise the commission, will try to get at essentials. They will have facilities for acquiring the facts necessary to form intelligent conclusions as to the best methods of helping gold and silver miners. By the time Congress has reassembled in ordinary session, the repurchases of silver under the Pittman Act should have been completed by several months, and the commission will have an excellent opportunity to point to a certain condition that is then expected to obtain, marshal the facts that it has gathered, and advocate a solution. Meanwhile, silver has been showing a surprising amount of strength lately.

The subjects are complex, and so many worldwide influences must be analyzed and weighed that helpful recommendations will not be easy to make. It goes without saying that any solution proposed should be sound and not conflict with economic principles, or the cure may be worse than the disease. But that is looking quite a distance ahead. The quick response of the Senate to the pleas of the gold and silver miners is gratifying.

The Overestimation of Geological Skill

THE RECENT DISCOVERY of a rich orebody in a hitherto little-developed Canadian mine has been publicly ascribed to the consulting geologist by his friends. One version is that this geologist had faith in the possibilities of the pre-Cambrian shield in Canada—hence his discovery of the orebody. Another version is that the geologist correctly calculated the depth of enrichment in the mine in question, and so guided the miners to the exact depth. Canada lies in the area of continental glaciation, and there is little or no "secondary enrichment" in this area. The glacier has planed away zones of oxidation and sulphide enrichment in general, laying bare to the surface the primary ores; and since the retreat of the glacier the time has been all too short for a redevelopment of these zones.

The rich ores of Cobalt, at first thought to be due to a secondary enrichment by surface waters, have been shown to be primary and the work of ascending hot solutions. Such rich ores have no stated relationship to the surface: the "depth of enrichment" cannot be calculated. Nor does a faith in the possibilities of the Canadian pre-Cambrian shield infallibly guide the expert geologist to the hidden orebody. He must show a demonstration of science and skill more convincing than the above explanations indicate before a discovery can be credited to geological acumen, and not that average of luck and pluck and common sense which uncovers the average mine. We have no doubt in this case that the skill of the geologist was a factor, but it was not on the grounds which have been ascribed by his friends.

The Best in Mining Education

"WHAT INSTITUTIONS, in your estimation, offer the strongest courses in mining engineering, in metallurgy, in petroleum engineering and in economic geology?" This is a specific question put to us. Our questioner states that he is a student at the ——— University, but that the problem of choosing the proper training involves so many factors not clear to one without extensive practical experience that he would be grateful for a statement of the conclusions of a more mature observer. The same question has been put to us a number of times.

We appreciate the difficulties of youth in the selection of a school from among the many. Years ago, when mining schools were few and far between, students from many different countries went to Freiberg. As late as 1910, no Americans were in attendance at Freiberg, and there were only about ten English students there at that time. Mining schools are now pretty well scattered over the world. The United States, no doubt, leads in the number of such schools. Due in part to local pride and in part to the spread of engineering education, these schools have multiplied to an excessive extent.

There is a tendency of the mining schools, as a group, to approximate a common type. At the inception of a new school, and when older schools are reorganized, mining curricula are scanned, and, according to the individual or the committee having the work in charge, the best is selected from each. It is easy to see how similarity is attained. Novelties in equipment and procedure are adopted from one school or another, and thus become common property. Distinction can only be obtained by radical departure; but this is rare, owing to the spirit of conservatism that characterizes educational institutions. However, appurtenances, curricula, and the trappings of the school are mere accessories.

Two vital complementary elements are the faculty

personnel and the student body. These determine the atmosphere of the place. A student body of earnest, capable men—good company, in other words—is one of the valuable assets of a school. Good leadership of the faculty is another. A preponderance of experienced teaching ability upon the faculty is most important. Men who have achieved distinction in the practice of mining and metallurgy are not necessarily good teachers. A faculty composed of such men looks well on paper but may leave much to be desired on the score of actual results. However, if they will work, they have a place in the research activities of the institution.

The key to the situation is the student himself. His individual effort counts most. A good faculty is an aid to increased efficiency on the part of the student. Unless he reads extensively, not only in his chosen line but also in other lines of engineering—unless he observes men and affairs generally, not only in his undergraduate but also in his after experience—he will not derive full value from his college education. Mining is a related part of a general scheme the understanding of which cannot be obtained by merely studying mining intensively. This truism also applies to the other subjects in the curricula of mining schools.

Solving the Treatment Problem of Complex Lead-Zinc Ores

WITH THE HIGH PRICES of lead and zinc that are now obtaining, added incentive is given to the production of those metals. Lead is particularly scarce, and no large deposits of lead ores have recently been discovered or developed, as has been the case with copper. Metallurgists are therefore turning to the economic treatment of a class of material which has so far been impossible to smelt without excessive losses—namely, ores containing the sulphides of lead and zinc in intimate mixture, usually with silver and gold and small quantities of other metals. Should this so-called complex-ore problem be solved, as there is every indication that it will be, the supply of lead and zinc will be augmented sufficiently to take care of all probable requirements for some time. These lead-zinc ores are not only common in certain districts of the West, as in Colorado and Idaho particularly, but are found in many other parts of the world, Australia and India being notable examples.

Until now, selective flotation has been the chief method of separation employed on a commercial scale. This has perhaps achieved its greatest development in Australia. As an example of what has been accomplished there, the Broken Hill South, Ltd., in the year ended June 30, 1922, treated an ore containing 14 per cent lead and 13 per cent zinc. Four products were made: concentrates containing 68 per cent lead and 7 per cent zinc; zinc tailings containing 3.4 per cent lead and 17 per cent zinc; quartz tailings containing 2 per cent lead and 7 per cent zinc; and slime containing 11 per cent lead and 13 per cent zinc. The slime was then subjected to selective flotation whereby a lead product containing 60 per cent lead and 9 per cent zinc was secured, and a zinc residue containing 2.4 per cent lead and 13 per cent zinc.

Several other companies are treating ores of a similar nature, among them being the Zinc Corporation, the Sulphide Corporation, and the Broken Hill Proprietary, the latter using the Bradford sulphur-dioxide process. On this continent the new plant of the Consolidated Mining & Smelting Co. at Trail, B. C., is an excellent example of selective flotation. The lead is first floated, and then the zinc, in a second machine. The rough lead concentrate is cleaned, and the tailing from the zinc machine is re-treated to recover more of the zinc. The zinc concentrate contains some lead, which is partially eliminated by tabling. Several other American plants have been more or less successful with selective flotation processes. The practice represents a big advance over any method of separation formerly used, but it has disadvantages. Where the lead and zinc sulphides are finely divided and intimately mixed, it is manifestly impossible to secure clean lead or zinc concentrates without finer grinding than is desirable. Thus the process is adapted only to certain ores, and even on these there is more lead in the zinc concentrates and more zinc in the lead concentrates than the metallurgist would like.

More recently, several processes based on chemical rather than physical principles have been developed, and it seems probable that these will have a more universal application and will result in higher recoveries. Complete descriptions cannot yet be published, for the processes are still in the development stage and the final method to be used will depend upon experiment. The Coolbaugh process will soon be tried out on a commercial scale by the American Smelting & Refining Co. at Durango, Colo. The ore is given a sulphate roasting followed by a water leaching. This dissolves most of the zinc and part of the copper sulphates. The copper is precipitated with lime or zinc oxide, and the water is evaporated from the remaining solution by spray driers, precipitating zinc sulphate crystals. The residue from the leaching contains the lead, part of the copper, and the gold and silver, and after being sintered is smelted in a lead furnace of regulation type.

Elmore, in London, plans to do just the opposite—removing the lead and silver first, and leaving the zinc in the residue. He has done a lot of experimental work on Burma ores, and is reported now to be conducting some large-scale experiments, after which further information should be available. Somewhat similar work is being carried out by the Bunker Hill & Sullivan company under the guidance of U. C. Tainton, formerly of Martinez, Calif. A fifty-ton plant is expected to be in operation by April 1. The process is said to embrace concentration, sulphate roasting, leaching, and electrolytic deposition of metallic lead upon rotating cathodes. The U. S. Bureau of Mines has carried on a great deal of work on chloridization followed by volatilization, and this method of attack also has interesting possibilities for the treatment of complex ores, though we believe it is not now being actively developed by a commercial company.

By the end of the year the complex-ore problem should be in a fair way of being solved, with all of the work that is being done. High prices of lead and zinc have led to this experimental work, but it is altogether likely one or more of the proposed processes will be developed to such an extent that they will prove economically possible when metal prices are down nearer the old levels. Although the ores to be used are impure according to old standards, it is notable that the lead and zinc which will be produced may well be of higher grade than is now generally made. This suggestion is made, having in mind, particularly, the electrolytic processes which are proposed.

Mining Law Revision

CONGRESSMAN ARENTZ, of Nevada, who introduced into the House the bill providing for a revision of the mining laws, which bill was accordingly called the Arentz bill, has been investigating the general sentiment in the West concerning this subject, in the long interval since the bill was brought forward.

He finds the sentiment concerning a repeal of the so-called "apex law" a mixed one. This of course is inevitable. Personal interest enters to a large measure into the views of people: and there are many whose personal interests would not be furthered by the loss of the extralateral rights to new locations. Added to these are the great mass of the stand-patters, those who react automatically instead of logically, and therefore view with disfavor any change—those who observe that the principles of Jefferson and Franklin are good enough for them. Legislation is to a great degree the net result of the pressure of personal interests, and there are few, if any, who have a strictly selfish interest in altering the present law of the apex. Reasoning thus, it is unlikely that it will be repealed.

There are issues better understood, and on which public opinion is clearer. One refers to the practice of a prospector relocating ground year after year without doing any assessment work—simply holding it down without development in the hope of some day making a sale to somebody. It is suggested that the law be amended so that a locator may not relocate ground until after the lapse of an intervening year. This would appear to be a wise precaution, since it would relieve the dog-in-the-manger situation, and would release an unworked claim to somebody that would develop it.

Another change which is commonly favored would make it possible legally to locate possible mineral land where the ore does not outcrop, and to hold it long enough to prove or disprove its mineral value, by means of sinking or drilling. The present law does not recognize the existence of mineral land where the ore does not outcrop; this law was drawn up at a period when the conceptions of ore and orebodies were more rudimentary than at present; and therefore it has been necessary, under it, to resort to subterfuge, equivocations, and more or less white lies, in order to hold and prospect land where the ore, if it exists, is covered by an overburden. Any law which does not fully recognize existing facts should occasionally be modified to correspond with those facts.

The provisions of the bill which required the recording of locations at a United States Land Office (instead of with a district or county recorder, as at present); that providing for the acceptance of cash in lieu of assessment work on claims; and that requiring the prospector to locate so as to conform to section lines, have not met with approval in general. The first and the last makes things harder for the prospector, and the advantage gained is not commensurate with the difficulty imposed; the second is widely, though not correctly, interpreted, as favoring the rich, who could thereby hold large numbers of claims without doing assessment work or other development. All three, indeed, have been held to favor the capitalist, and to disregard the prospector, and therefore the opposition to them has been widespread, and a general conspiracy on the part of the larger companies has been read into the bill by many in the West. It is quite unnecessary to add that the interpretation was ridiculous: the reasoning by which some have arrived at that conclusion is, nevertheless, what has been shown above.

Whether any modified mining law will ever really come before Congress for action is a question. There is undoubtedly a general popular sentiment toward standing pat.

Raw Material

A CORRESPONDENT from Oklahoma writes that there are all degrees of crudity and all stages of smoothness in the methods used by the unscrupulous promoter to separate the inexperienced investor from his savings: but for the raw stuff he feels that one Paul Vitek, "Trustee" of the Vitek Oil & Refining Co. of El Dorado, Ark., deserves honorable mention. His circular letter start: "From Paul Vitek, To You, a Seeker After Wealth." "Yes," (says our correspondent) "I have quoted correctly—it reads 'Seeker,' and not 'Sucker.'" And

"Another week has passed since I wrote you—and still you hesitate. Have you not *Faith?*" Also

"Before three months have passed away it is my expectation to have distributed more than *one thousand per cent in cash* to each and every man and woman who invests with me.

And yet, you hesitate!"

"During the last 60 days I have paid 200 per cent in cash to my stockholders. But I am just starting. The investors of the Nation are swamping me with their dollars, and I am using every single dollar to get more proven leases, bring in more gushers, drill well after well—pay 100 per cent after 100 per cent to those who have the *Faith* in me to place their money in my hands." As our correspondent understands it, he is using new money to pay dividends on old money—if he gets what is meant. Anyhow, he observes that Paul is certainly a conspicuous hallelujah shouter and an exponent of *Faith*: for he says "I feel certain in my heart I can complete *Twenty*, yes *Thirty Gushers* during the next six months, and pay *Two Thousand, Three Thousand*, yes *Ten Thousand Per Cent in cold cash* to those who have *Faith* in me today."

He says "The present price of shares of my company is *Ten Dollars*, par value. Next week, perhaps *Fifty Dollars!*" At ten thousand per cent in six months (writes our correspondent), if I invest a hundred dollars, I shall get back a million, or in a year two million, but if I put in my whole pile, or $237, I shall in a year receive dividends of $4,740,000. Aye—but how about the safety of the principal? Would it not be more conservative to invest in Liberty Bonds, and be sure of the safety of my principal?

"A flood of Wealth such as the world never knew before is engulfing my stockholders and myself." Moved to amend (writes our correspondent) by striking out the words "the world" and substituting the word "I" and by striking out the phrase "my stockholders."

"I have only a certain number of shares to sell before I am completely financed. Will you hesitate longer or will you join me?" We'll think it over, Paul (says our correspondent). Meanwhile, please find inclosed ten cents; I have *Faith* in you and in your statement that you can earn ten thousand per cent in six months on it; that will give me an income of two thousand dollars a year, on which I can subsist in comfort at some first-class sanitarium.

Mine-Fire Regulations

By T. A. Rickard

AN APPROPRIATE MEMORIAL to the forty-seven men that lost their lives in the Argonaut disaster is being erected in California; it takes the form of precautions and orders designed to prevent and check the danger from fire in mines. The precautions, I venture to say, will prove more effective than the orders; by which I mean that the steps taken on their own initiative by the owners and managers of mines since the Argonaut disaster are likely to prove more to the point than the regulations promulgated by the Industrial Accident Commission. The "mine-fire control safety orders" of that commission are published on another page of this issue. They will interest those in charge of mines as a serious attempt to perform a humanitarian and economic service. They are more elaborate than any set of regulations for this purpose in force elsewhere, I believe; they are onerous, and therefore open to the criticism of being impracticable. Their elaboration errs on the side of excess, for it must be noted that in the fifty years preceding the Argonaut disaster only twenty men lost their lives in mine fires in California. This represents only 1 per cent of all the men killed in mines in this state during the period specified, so that this profuse set of regulations represents an effort to meet a hazard that represents only 1 per cent of the total hazard to be faced in mining. Our mining operations in California, outside oil exploitation, consist chiefly of digging for gold, in lodes, and in placers; we have but few of the dangerous type of mines, such as those in which inflammable coal and combustible copper sulphides are exploited.

For example, the call for places of refuge is reasonable in such mines as those at Butte or in other sulphide mines where fires are frequent, but they seem hardly necessary in a gold-quartz mine of the small size usual in California. At the Argonaut such a place of refuge might have proved useful, but it would not have been required if the secondary exit had been made available by reversing the draft, nor would it have been needed if the lower workings of the Argonaut had been connected with those of its neighbor, the Kennedy. We note two safety orders that seem directly to embody the lessons of the disaster last August: (1) the insistence on a connection between the working levels of contiguous mines, and (2) the rule for posting conspicuously a diagram showing the exits, principal workings, fire doors, telephones, air pipes, and air currents. Manifestly, it is unfair to ask men to go underground blindfolded, as it were; they are entitled to a chart and other information needed to facilitate escape in case of fire or any other serious accident.

Another echo of the Argonaut fire is suggested by the provision for double telephone lines and the placing of them in separate shafts. The demand for making the fan reversible is a belated acknowledgment by the engineers of the Accident Commission that the reversing of the fan at the Argonaut might have saved the men. To this and other criticisms it may be replied fairly that the regulations in question are more in the nature of suggestions than of peremptory rules, because they are subject to numerous exemptions designed to meet varying conditions. This gives elasticity to the regulations, but puts them at the mercy of interpretation by the commission, which consists of three men entirely lacking experience in mining and therefore dependent for guidance upon their Engineer of Safety, himself not in sympathy with those in charge of the mines.

Many of the accidents—30 to 40 per cent of them—in the mines of California are caused by falls of rock, and against these the chief admonition is to break down the "back" by means of a pick. The safety regulations already in effect are drastic and detailed; they are recorded on fourteen pages of print. The new fire regulations appear to add needlessly to the convolutions of red tape, because in the last resort the effectiveness of any safety regulations will depend upon the moral authority, rather than the legal power, of officials.

From the preamble of these safety orders one might suppose that the mine operators had been mainly instrumental in formulating the new rules. The facts are otherwise. At the time of the Argonaut disaster a committee of eight experienced engineers was appointed by the American Mining Congress, at the Cleveland meeting, to devise a set of regulations. These were brought to San Francisco by a member of that committee, Mr. Edwin Higgins, and served as a basis for discussion by a committee of sixteen engineers and operators, with bureau and commission officials selected by the Industrial Accident Commission. This larger committee drafted a series of regulations, which the commission in turn changed and amplified as it saw fit, making them so much more elaborate as to arouse antagonism, and including clauses that the Committee of Sixteen had voted down. In effect this pretentious set of safety orders is a sop to the Cerberus of public opinion and an attempt to placate the resentment felt against the engineers of the Industrial Accident Commission for their failure to take steps that would have prevented the loss of life at the Argonaut.

Heretofore, in California and in other states, nobody has presumed to formulate fire regulations applicable to all mines, it being recognized generally by experienced men that the diversity of conditions obtaining at different mines renders impracticable the application of any blanket legislation. To attempt to apply any set of drastic rules is likely to do injustice to the individual operator, despite the right of appeal for exemption; and the injustice will be the greater the more conscientious and law-abiding the operator may happen to be. In practice it will be found advisable, I believe, to adopt a policy not so much of imposing disciplinary measures in advance as of proffering suggestions, followed by inspection by an engineer whose moral authority is strong, not only by reason of experience in mining but also on account of fairness of mind and the obvious desire to safeguard the lives of employees.

After all is said and done, the best protection for the men in the mine is the management of an experienced superintendent. As one cannot make people moral by act of Congress, so one cannot remove the factor of danger in underground operations by any code of regulations. From the humanitarian as well as from the economic standpoint it is incumbent on mining companies to put their mines in the hands of experienced engineers.

DISCUSSION

"Engineering and Mining Journal-Press" is not responsible for statements or opinions published under "Discussion." In many cases the views expressed are diametrically opposed to editorial policy and belief.

Does Sampling Practice Need Revision?

THE EDITOR:

Sir—Professor Hersam, in his discussion in the *Journal-Press* of Feb. 3, seems to think there is a standard practice in sampling, and that this practice is rather closely followed; but such men as D. W. Brunton, John A. Church, and T. R. Woodbridge have emphatically pointed out the utter lack of any common ground of understanding as to this important operation. Mr. Church said,[1] in regard to ore sampling in general, that "the work done is so irregular that it is high time to consider the question and determine what can be done to improve the work." Mr. Brunton says (in a paper[2] which appeared fourteen years later than the one to which Professor Hersam refers) that "the art of sampling has now reached a stage where a standardization of methods is both desirable and possible." He urges a thorough investigation, and closes with the assertion that such an inquiry will do much to eliminate faulty methods and will "prove of inestimable benefit to the mining and metallurgical industries from both a business and a scientific point of view."

In his "Ore Sampling Conditions in the West" Mr. Woodbridge remarks[3] that "in spite of its importance a large part of the ore sampling of today is not done on a scientific basis," and adds that "most sellers and buyers are frankly disgusted with the persistent use of incorrect methods and would welcome a thorough investigation and discussion of the subject." In private correspondence during the last few months, Mr. Brunton says, "I hope that you will continue writing on the subject until the members of the profession will pay more attention to this most important and difficult operation"; and Mr. Woodbridge, in a recent letter, is quite as emphatic as he was in the publication mentioned as to the need for radical improvement.

The table of "Data From Practice," on p. 283 of the *Journal-Press* of Aug. 12, 1922, was presented for the very purpose of showing how uncertain, and in many cases how illogical, the mill work is. This was emphasized in some detail by our discussion on p. 280 of that paper. These data were not selected to prove a point, but included all cases that have come to our attention. In the above data mills K and 50 (the latter quoted from the Bureau of Mines paper) are alike, except that mill 50 shows twice as much ore at all stages as does mill K, and it would seem that here are two mills that have something of a common point of view; but we have since found that these two are really the same mill, one source of information starting with a twenty-five ton lot, the other with fifty tons.

There is one practice that is often thought of as standard—namely, that of making a 2 to 1 size reduction at each stage of crushing while taking 20 per cent cuts at each stage of sampling. However, few mills that start on this basis seem to hold to it. In the table of "Data From Practice," mills D and 41 nominally use this rule, but practically they depart from it. Neither of them provides a steady feed to the sample cutters; and the paper in which they are mentioned shows how seriously that defect reduces the quantity of ore actually taken for a sample. Moreover, at least one of these two mills fails, in fact, to crush as finely as it sets out to do, its crushed products often being 50 to 80 per cent coarser than nominal.

Mr. Woodbridge's monograph also lays considerable stress on the failure to provide a steady feed to each sample cutter. He pertinently remarks that when a cut from one sampling machine "passes entirely into the reject of the second machine, the effect of that particular sample portion is absolutely lost, and as far as it affects the final sample it might as well have been left in the mine or have been hurled at once into the reject of the first machine."

Of the mills that started with the practice of 2 to 1 size reduction, but later departed from it, some made the change at the coarser stages; others at the finer stages of crushing. These modifications suggest that the operators are afraid to trust the rule with which they start. It would seem as though the real trouble is that the proper method for determining good practice is but little known, and so the operators resort to a mere cut-and-try. One man, who has wide sampling experience and has seen many plants, is convinced that "only a nominal number of mills are designed to crush by any rule. Rather, it was a guess as to what was safe, and at the same time as economical of power and labor as possible." He adds that not over 10 per cent of the numerous mills he has inspected seem to have been "built or even operated on any conceivable rule."

All this is said not for the mere sake of discrediting current practice but to show the state of the art and to indicate what we are convinced is the best way out of the woods. Though much engineering practice is firmly established on indisputable principles, considerable of it is still altogether empirical. Correct sampling certainly depends on the laws of probability. It would be convenient if every sampling problem could be worked out with a little arithmetic, but it cannot be done so easily. Any good miner can follow the ore in a simple, undisturbed vein system; but where there is complicated faulting the special knowledge and skill of a geologist is required. So also with the intricate problems of a metallurgical plant. The mechanical operation of a sample mill is comparatively simple to those familiar with such work; but here again the scientific foundation of success in the business is a matter of special knowledge and skill. It avoids the trouble of a long-drawn series of changes, by going straight to the heart of the matter.

[1] *Eng. and Min. Journ.*, Nov. 14, 1908, p. 951.
[2] *Trans.*, A.I.M.E., Vol. XL, p. 596.
[3] *Technical Paper* 86, U. S. Bureau of Mines.

We thoroughly believe that the heart of the matter is the method outlined in the paper on "Mechanical Sampling of Ore."[1] Professor Hersam feels sure that we erred in the mathematics of the method, but we call attention to three places where the fallacy of his contention is shown: Appendix C of Berringer's "Assaying"; Richards' "Ore Dressing," Vol. II, p. 850; and in our paper just referred to. His contention is that the exponent a "is constant and has the value 3." The one case, in the "Data From Practice," where the exponent is 3, indicates a ridiculously small quantity of pulp for a gold assay (0.028 g. through 150-mesh sieve).

For the ores described in our two preceding papers we did not assign values for the exponent a of the general equation, $W = kD^a$. The values stated were fixed by the qualities of the ores themselves, as determined by careful tests. So also were the values of the coefficient k.

	k	a	Grams for Assay at 0.1 Mm. (150 Mesh)
Copper	600	2.32	0.72
Copper	700	2.37	0.62
Copper	2,100	2.48	1.0
Spotty gold	576,000	2.90	27.7

The fact that all these values for a are less than 3 confirms the theoretical proof that 3 is not a proper value for real ores. The variations prove that no constant value of a can be used for all ores. And the accuracy of the method is shown by the quantities which the tests indicate for assay of 150-mesh pulp, as given in the last column of the above tabulation. All of these assay weights are just such as experience shows to be suitable for correct assaying.

As to Mr. Brunton's formula being preferable, its difficulties are indicated at the end of the present discussion, for those who wish to consider the mathematics.

The use of the word "spotty" is criticised as not being definite enough to describe an ore. "Rich," "poor," "good," and "bad" are not precise terms, but they are all perfectly good descriptive words. Neither technical nor scientific language may be confined to phrases of mathematically exact meaning without great loss. To the sampler, "spotty" indicates that an ore has its valuable metal more irregularly distributed than does the ordinary run of ores, and for that reason he must take more than usual precautions in his work.

The purpose of the article on "Sampling Spotty Gold Ores" was not to describe experience in an isolated case, but to show that the method described in the earlier paper is just as useful in such cases as for ordinary base-metal ores.

The occasional serious unexplained losses shown by monthly metallurgical results, or of such good balances as 99.8 per cent or 100.2 per cent in a plant where there is usually a much larger discrepancy, are strictly in harmony with the laws of probability. These results are exactly parallel to what happens in games of chance. In an article describing the roulette games at Monte Carlo there was related the remarkable runs of winning that once in a great while come to some players. Such things happen not because a "system" has been found that "beats the house," but because, in the operation of the laws of probability, these things will sometimes occur, though nobody can tell when to expect them. However, if the "house" has enough capital to carry it over the occasional times when things come the way of some players, it inevitably wins, and without cheating, because the chances are all arranged with that end in view. In properly devised sampling, on the other hand, the chances are deliberately arranged to insure whatever degree of accuracy is needed; for example, to determine the metal value within, say, 0.1 per cent, or 0.03 per cent, of the true content.

It is sometimes argued that though daily samples may not be right, the monthly results come out correctly, on account of the law of averages, which tends to offset the plus errors of one day by the minus errors of another. But, where the averaging process is depended on, there come times when this kind of balancing fails. The superintendent and accountants then work overtime in the vain attempt to explain to the head office where the values have gone. But, when the method described in the paper on "Mechanical Sampling of Ore" is applied to the work, each day's samples are right; and so, of course, the monthly balance is right.

Moreover, there would be a good deal less worry and uncertainty in the daily operation of smelters and leaching plants if each day's samples were strictly accurate. A false sample leads not only to errors in reporting the metal value but also to misinformation as to the acid or basic quality of the ore. Correct samples permit much more exact fluxing, and proportioning of reagents, and thus lead to smoother operation and smaller losses in slag and tailing.

The difficulties of Brunton's formula previously referred to are indicated in the following:

[It will be well to generalize Mr. Brunton's particular assumption. We follow his notation:

"Let W = weight of sample in pounds,
k = grade of richest mineral, in ounces per ton,
c = average grade of ore, in ounces per ton,
s = specific gravity of richest mineral,
n = number of maximum-sized particles of richest mineral in excess or deficit in sample,
f = a factor expressing the ratio of the actual weight of richest mineral in the largest particles which will pass a screen of given size, to the weight of the largest cubes of richest mineral which will pass the same screen,
p = allowable percentage error in sample,
D = diameter in inches of the holes in screen, or the nominal diameter to which the ore is crushed."

"Then, the weight of a cubic inch of water being 0.036 lb., the weight of a maximum *cube* of richest mineral is $0.036sD^3$ and the actual weight of a maximum *particle* of richest mineral is $0.036fsD^3$."

"The silver contents of a maximum *particle* of richest mineral are $\frac{0.036\ fskD^3}{29166}$"

"The silver contents of a particle of same weight but of average grade are $\frac{0.036\ fscD^3}{29166}$"

"Then the deviation caused by one maximum particle of richest mineral in excess or deficit in sample is

$$\frac{0.036\ fsD^3}{29166} - \frac{0.036\ fscD^3}{29166} = \frac{0.036\ fsD^3}{29166}(k - c)$$"

Since there is a range of sizes of particles of both the richest and the poorest minerals, we may consider the deviation caused by a particle of richest mineral in excess or deficit, in a sample, whose size is $(D - \Delta D)$, where ΔD is a small increment of size. This deviation is $\frac{0.036\ fs\ (D - \Delta D)^3}{29166}(k - c)$. Similarly, consider sizes of $(D - 2\Delta D), \ldots (D - m\Delta D), \ldots$ etc. The several deviations are $\frac{0.036\ fsD^3}{29166}(k - c); \ldots$

$\frac{0.036\ fs\ (D - \Delta D)^3}{29166}(k - c); \ldots \frac{0.036\ fs\ (D - m\Delta D)^3}{29166}$

$(k - c) \ldots$ etc.

Just how many terms need be considered it is difficult to say. Furthermore, a plus deviation in one case may be offset by minus deviations in others. Both plus and minus

[1] *Eng. and Min. Journ.-Press*, Aug. 12, 1922, p. 282.

occur. It can be shown that these deviations taken all together, as affecting the accuracy of the sample, may be expressed by

$$\text{Standard deviation} = \sqrt{\left(\frac{q_1}{100}\right)^2\left(\frac{0.036fsD^2\ (k-c)}{29166}\right)^2+\left(\frac{q_2}{100}\right)^2\left(\frac{0.036(D-\Delta D)^3\ (k-c)}{29166}\right)^2+\ldots+\left(\frac{q_m}{100}\right)^2\left(\frac{0.036fs(D-m\Delta D)^3(k-c)}{29166}\right)^2+\ldots}$$

where $q_1 \ldots q_m \ldots$ are several percentages of materials, of sizes $D \ldots (D - m\Delta D) \ldots$

"The silver contents of the sample should be $\frac{Wc}{29166}$, and the allowable error is $\frac{Wcp}{29166 \times 100}$. If this error is caused by n maximum particles of the richest mineral in excess or deficit, we have $\frac{0.036fsnD^3}{29166}(k-c) = \frac{Wcp}{29166 \times 100}$, from which $3.6fsnD^3\ (k-c) = Wcp$."

Again it may be stated that there is a range of sizes, and we place

$$\sqrt{\left(\frac{q_1}{100}\right)^2\left(\frac{0.036fsn_1\ D^3\ (k-c)}{29166}\right)^2+\ldots+\left(\frac{q_m}{100}\right)^2\left(\frac{0.036fsn_m\ (D-m\Delta D)^3\ (k-c)}{29166}\right)^2+\ldots=\frac{Wcp}{29166}}.$$

The relationships are not simple as between W and the several diameters, and are difficult of definite calculation. How many shall n_1, n_2, n_m, etc., be? A very large number of assumptions can be made, and how can we know which combination in an assumption is most likely to be correct? Neither does it appear that a simple coefficient before these several sizes can be readily evaluated.

Because experience has shown that weights need not be proportional to the cube of the diameter, we considered it reasonable to assume that ores in general can be made to fit the family of curves $W = k\ D^n$. We found this to be the case with three copper ores.

On p. 837 of Mr. Brunton's paper is a table of assays in which arithmetical deviations are given. These deviations are a measure of excess or deficit of valuable mineral throughout the entire range of sizes of such mineral in the sample. Clearly, increasing the weight of the sample will increase the number of particles selected, and therefore increase the accuracy. The amount of the increase necessary is easily calculated if a sufficient number of assays is made. Points on a curve, for any particular class of ores, can be determined thus. Having determined them, it is a question of passing a curve through them.

It does not appear that the distribution of valuable minerals in an ore is a straight line function as we crush from coarse to fine sizes; but a simple coefficient in a sampling equation, with an invariable exponent, assumes that such is true. To make the exponent invariable and of a value 3 necessitates a further term in the equation, containing a variable, or the introduction of a variable into the coefficient.

CHARLES D. DEMOND,
A. C. HALFERDAHL.

Anaconda, Mont.

Platinum in Oregon

THE EDITOR:

Sir—In the issue of June 10, 1922, there is an article by A. E. Kellogg in regard to platinum in quartz in southwest Oregon. In the eighth paragraph he says: "Surprising values in platinum quartz were found two years ago in Curry County, running from 10 to 20 oz. per ton." I have been living in that section of the country for the past twenty-three years and engaged in mining. I know all about that "discovery." Those values were found by an assayer at Bandon. There were no real assayers that could find any platinum. There was some mica and iron but no fissure veins. I was called twice to go and look at prospects.

There is considerable platinum and iridium recovered in this section, but it all comes from the placers, principally from the black-sand mines which are: the present ocean beach; a range of old beach at an elevation of about 200 ft.; then another back of that at about 900 ft.

Elk River, in Curry County, is known to be the stream richest in platinum in the United States, but is mined very little.

GEORGE W. AXTELL.

Port Orford, Ore.

The Self-Dumping Bucket Once More

THE EDITOR:

Sir—Having read with interest the divers comments on the "self-dumping bucket" which has been installed at the Black Hawk and several other shafts at Randsburg, I venture to offer a criticism of the arrangement.

After an experience of twenty-four years at mining in Arizona, California, Colorado, Nevada, and Wyoming, I have concluded that the dumping of a sinking bucket is of but minor importance when compared with the other necessary operations of shaft sinking, such as timbering, mucking, drilling, and complementary operations. With the arrangement at the Black Hawk, dumping the bucket seems to be the important part of the work that is being done and takes precedence over what I should consider much more important work.

Under this arrangement only one bucket can be used, and as it requires from three to four minutes to make a hoist trip in even a shallow mine, it is evident that the shaft men must necessarily be sitting in the bottom waiting for the return of the bucket when they should be filling the second one. Another thing: it is difficult to move the bucket around in the bottom of the shaft while mucking, which is an important item, especially if the shaft be of three compartments. Still another objection is that the bucket is permanently fastened to the chains which carry it, and all the timbers must be lowered in the bucket unless, perchance, the headframe is high enough to allow them to be swung under the bucket, which is not likely to be the condition at a mere prospect. As a consequence, the timbers must be taken out of the bucket by "main strength and awkwardness," regardless as to their length and weight.

True, the operator may save expense of a top man, but a top man is nearly always hired at a dollar a day less than the shaft men are, and when the shaft men are sitting in the bottom waiting for the bucket half the time I cannot see where the economy comes in.

A miner who worked under one of the installations and who has, to my own knowledge, had an extensive experience in shaft sinking, told me of the inconvenience of shoveling into the bucket "with the two chains always in the way and the two horns on the bucket hooking him in the legs at every move." This miner also spoke of the chains keeping his body so much nearer to the timbers while descending and ascending the shaft than would be the case with a single rope.

Still further, as the arrangement is being installed here in Randsburg it requires a four-post frame, which in itself adds approximately one-third to the cost of the frame, and, with the iron and blacksmithing that it required, I would not hesitate to say that the cost would exceed by one-third that of an ordinary dumper such as is being used in many old mining districts.

Randsburg, Calif. ATHA A. RICHIE.

Metallurgists of Note

EDWARD H. HAMILTON

EASILY the most sensational feature of the grand reunion of McGill University alumni held in Montreal in October, 1921, was the 100-yd. foot race for "old grads." Now, an "old grad" does not necessarily need to be very old; and as a matter of fact some of the thirty contestants in this event were only a few years out of college and some of them had made reputations as sprinters in their undergraduate days. However, the man who broke the tape in this memorable event had graduated with the class of '83. If we assure the reader that the victor was not an intellectual prodigy, but a normal student, a reasonably accurate guess and a little mental arithmetic will enable him to estimate the approximate age of this particular "old grad." The conclusion as to whether he was "old" or not will probably depend upon the number of winters that the individual estimator himself has weathered. Suffice to say, that the winner was none other than the redoubtable "Harry" Hamilton, one-time captain and star of numerous McGill football teams, and before that, when only eighteen years of age, member of the "All Canada" cricket team. We are assured that when he played cricket, his mind was on cricket and not on drinking tea. As Edward H. Hamilton he now manages the Midvale smelter of the United States Mining, Smelting & Refining Co. Those who know, say that he puts as much concentrated energy, skill, and enthusiasm into making the plant go properly as he did in running a football team. He thrives on difficult metallurgical problems. To him the solution of them is a sport. He likes to work hard, providing the work has to do with getting the greatest possible amount of metal out of ore or concentrate at the least cost. He is not a technician who lets the lure of a high metallurgical recovery blind him to the greater importance of final economic results. Perhaps his most widely known achievement is the successful development of the use of powdered coal as fuel for Dwight-Lloyd machines and for lead blast furnaces. We have heard Mr. Hamilton described by a certain word which implies a rather restricted sphere of activity; but we are not sure that it characterizes him accurately. If the reader feels that he can qualify as an "expert" witness, let him give his own answer to the following hypothetical question:

EDWARD H. HAMILTON

If a mining engineer gives but casual attention to the business of solving the riddles of geology; if he cares little for the intricate processes of opening a mine, and keeping it open, of breaking rock and loading it and hoisting it; if he fails to enthuse particularly over the work of the ore dresser who grinds up the ore, and shakes, or floats, or otherwise separates the more valuable particles from the less; but if he had, as assistant superintendent for the Pueblo Smelting & Refining Co., recovered bullion from lead ore and then separated the pure lead, silver and gold by the Parkes process; and if he had built and operated a zinc plant with Belgian type gas-fired furnaces as superintendent for the United States Zinc Co.; and if he had been assistant to E. P. Mathewson for three years when the first great reverberatories and blast furnaces, flues, and stacks were built at Anaconda; and if he had started the first large oil-fired reverberatory as general superintendent at Humboldt, Ariz., for the Consolidated Arizona Smelting Co.; and if he had been consulting engineer for the A. S. & R. Co., at the Garfield smelter; and if as manager for the Virginia Smelting Co., at Norfolk, Va., he had developed unusual processes for treating copper sulphide, pyritic sinter, zinc residues and other products; and if he had produced gold, silver, electrolytic lead, electrolytic copper, sulphuric acid, hydrofluosilicic acid, and later cathode zinc at Trail, B. C., as manager for the Consolidated Mining & Smelting Co., and if he had served for the last five years as superintendent for the United States company at Midvale, where among other things he had developed a method for producing white arsenic, sodium arsenite, and calcium arsenite—if all these things were so, would this engineer be a mere "specialist"? Mr. Hamilton has been described, by no means disparagingly, as a metallurgical specialist. If our own opinion were asked, we would say that he is at least an exceedingly versatile specialist.

Examination of Tin Deposits in the Federated Malay States—II

Sampling Procedure Followed at Ampang by Yukon Gold Co.—Office Methods—Total Costs of Various Operations Summarized

BY J. B. NEWSOM

J. B. Newsom

THE OBJECT of sampling was primarily to determine the number of pounds of tin per cubic yard in the ground and also its distribution. Other things noted were: The size and angularity of the cassiterite; the percentage by volume; distribution and character of the sand in the ground; the character of the clay or mud; the stickiness of the ground, and how difficult it would be to break up the puddle. Depth to bedrock, the character of the bedrock, and the surface conditions were also recorded. These items were recorded on the drill logs. See Fig. 1. An original log and one duplicate log were made for each drill hole.

At the drill, all the dirt from each 5-ft. depth of the hole was measured in boxes holding one imperial gallon. The number of boxes in each sample was recorded to the nearest tenth of a box. The sample was then put in sacks and taken to a field washing plant.

The tags (Fig. 2-A) used on the sacks were stout envelopes. These were filled out by the foreman in charge of the drill. Under "Formation" was written a description of the material composing the sample. In case the sample was the last to be taken from the hole, "Not reached," "Hard limestone," or some other descriptive statement was written after "Bedrock." If pieces of bedrock had been brought up by the tools, a fragment was inserted in the envelope. After a sample had been washed, the concentrate was weighed, wrapped in paper, and placed in the envelope. The tags from each hole were then tied together and filed as a unit.

Data obtained in the field were entered on the drill logs at the washing plant. The first five columns were filled from the sample tags. The sixth column showed the water displacement of the samples in "gantangs" (imperial gallons). Box measure was a rough check on displacement.

After the displacement had been measured, the washing-plant coolies kneaded and stirred each sample with

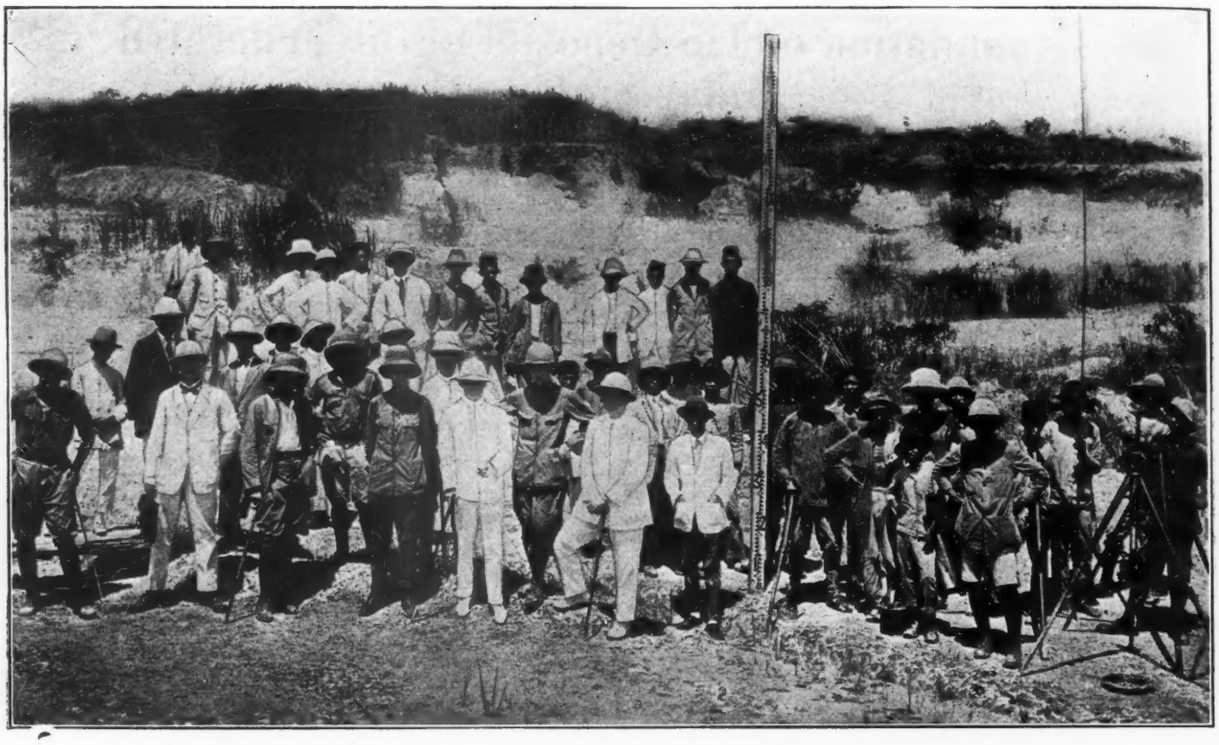
2/7/20 DRILL NO. 8 HAND DRILL FIELD LOG. SHOE 3½ IN.

Examination AMPANG — Line 20 L — Hole 20L-432 — Total Depth 39 — Value lbs. per cu. yd. 75% 4.41
Location of Hole: 10 ft. N. of stake on account of large tree — Date 1/7/20 — Depth cut off 5 — " " " " " 13.80
Elev. 157 — Depth Figured 34 — " " " " " 2.97
W L. 5 ft. B.R. 39 ft. — Figured by CK. Weldon

Sample No	Depths in Feet: Pipe	Hole	In Sample	Volume in Gantangs: Box Measure	Displacement	Sand	Per cent Sand	Concentrate: Chows	Character	Reduced to 73%	73 per cent: Chows per Gantang	lbs. per cu. yd.	D x V.		Notes on Formation	H. W. M. W. or E. W.	Legend
A	10	10	10	4.00	3.60	.90	03		00	—		00				Brown Dirt. No Cl very F Sd.	E.W.	Cl Clay
B	15	15	5	3.55	3.40	.30	09		10			10		04	20	T. white Cl. M. Ang Sd.	H.W.	C. Coarse
C	17	18	3	2.00	1.90	.10	05		14			14		10	30	" " " " "	H.W.	M. Medium
2/7/20 D	20	20	2	1.50	1.70	.10	06		13			13		10	21	" " F. " "	H.W.	F. Fine
E	25	25	5	4.00	3.50	1.50	43	1	04		1	04		40	2 00	S. SK yellow cl. M Ang. Sd	M.W.	H. Hard
F	30	30	5	5.15	4.50	4.00	89	15	37		15	37	4	55	22 75	C. Ang. Sd.	F.W.	S. Soft
G	35	35	5	4.90	4.70	4.00	85	75	82		75	82	21	53	107 65	" " " L. S. Frags.	E.W.	Sd. Sand
H	37	38.5	3.5	3.55	3.20	3.00	94	25	15		25	15	10	48	36 68	" " " " "	E.W.	Fr. Friable
															169 79			T. Tough
															68 98			Sh. Sticky
															100 81			Cem. Cement
Total Avgs.	37	38.5	38.5	28.65	26.50	13.19		120.48								Bedrock — Limestone (Fr.)		

Contractor Wong Kim — Kapalla Sew Loom — Foreman Abdul Mohamed — Tin Washer Hong Koh
Remarks: H. L. Beal — Washing Plant.
On the side of a small hill, near several old shafts.
Bedrock = Pink Limestone.
O J Smith — FIELD ENGINEER.
Entered in Summary Book W. R. Jones — Plotted on Cross Section CT CK — Plotted on map CT CK

Fig. 1—Drill log filled out

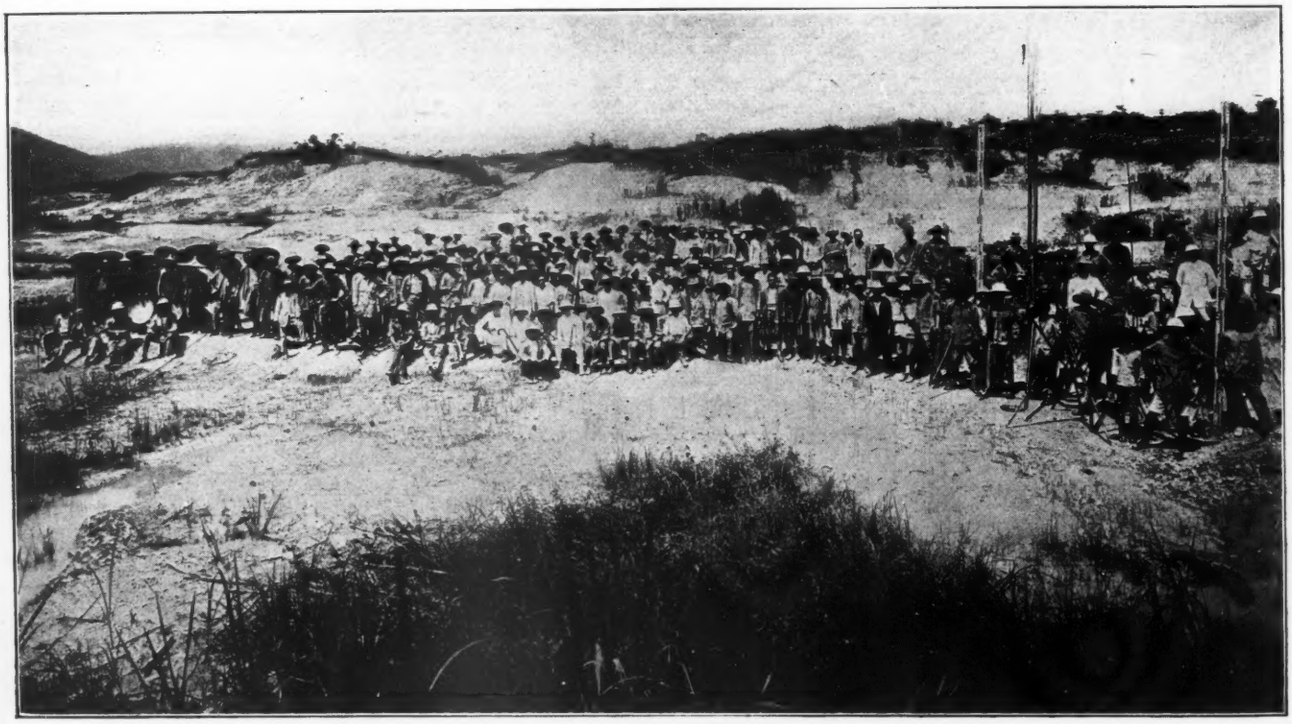


Engineers, assistants, office force, and surveying crew of Ampang examination

their hands, keeping the sample under water, until all the clay had floated off. This left a residue of clean sand, the volume of which was measured and recorded under "Sand." While the sample was being kneaded, the man in charge of the washing plant examined it and filled in "Notes on formation." He also put a note under the heading "H. W., M. W. or E. W." (meaning hard, medium or easy to wash).

After the sand had been measured it was put in a shallow wooden bowl about 2 ft. in diameter, and the lighter sand was washed away. This left a residue of black sand and cassiterite, which was put in a small tin container with a slip to identify the sample. See Fig. 2-B. At the end of each day the samples were sent, in a locked box, by motor car to the Kuala Lumpur office.

The next morning an expert Chinese tin-washer concentrated the samples until they were about 73 per cent



Field organization, including surveyors for thirteen drills, Ampang, 1920

tin. After the samples were washed they were dried and put on the weigher's table.

They were weighed by one of the engineers. Weights were taken in native units[1] using a Chinese tin balance.

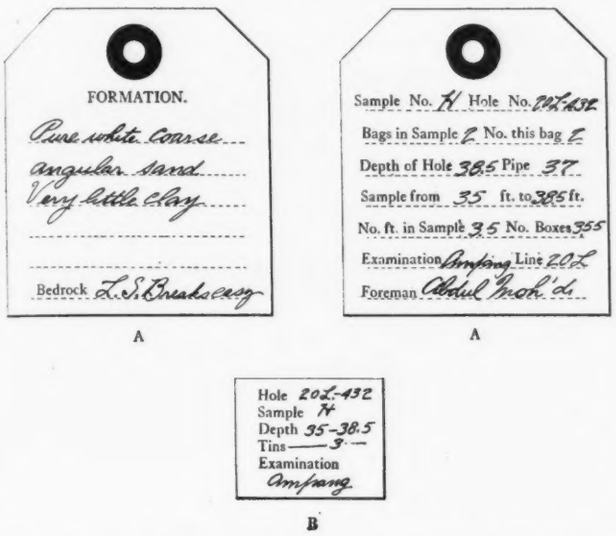


Fig. 2—A, Sample tag, filled out at drill. B, Sample slips, put with sample at washing plant

See Fig. 3. The character of the cassiterite was recorded as coarse, medium, or fine. The weights and character of samples were recorded in a note book, a temporary record in which one page was allotted to each hole.

Weighing samples from the drill holes is shown in the photograph on the cover. The samples were sorted and passed to the weigher by the clerk on the left. After the weights were taken the samples were wrapped with the tags which may be seen in the foreground. The balance used was the ordinary native lever and fulcrum balance having a small brass pan, an ivory lever

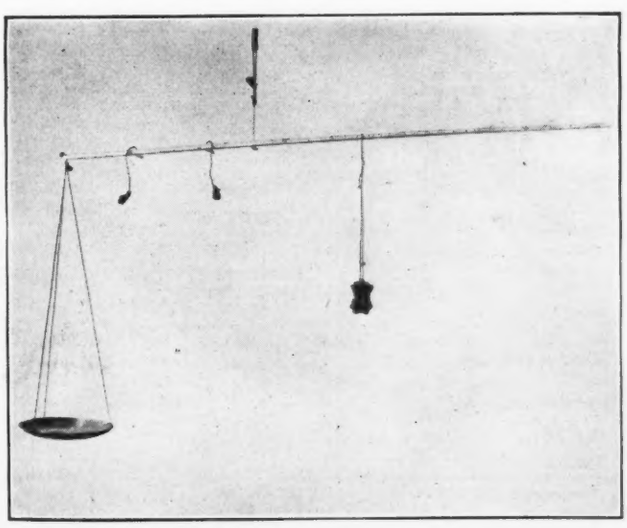


Fig. 3—Lever and fulcrum balance used by natives

marked in native weights, and a sliding brass balance on a string. Weights were taken to the nearest hundredth of a chee (the chee equals 0.133 oz. avoirdupois).

As soon as a hole was finished, the logs for it were

[1]10 "chees" = 1 "tahil" = 1⅓ oz. avoirdupois; 16 "tahil" = 1 "kati" = 1⅓ lb. avoirdupois.

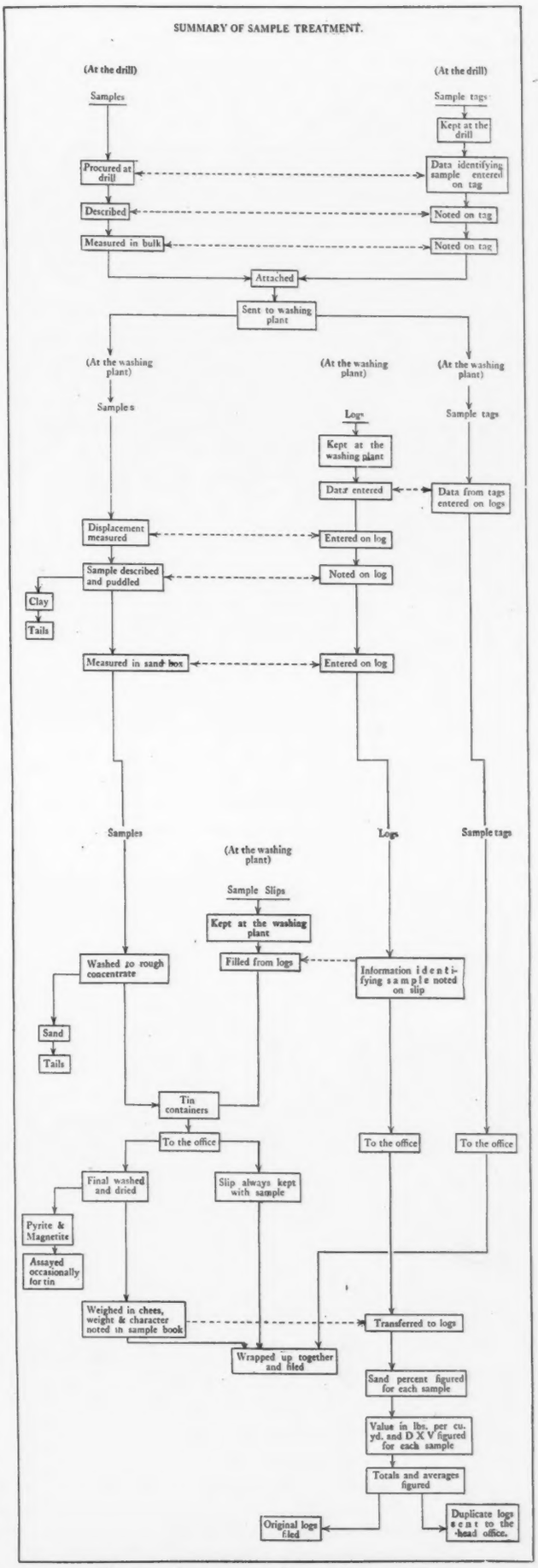


Fig. 4—Summary of sample treatment

sent to the office. Weights were there transferred from the sample book into the column "Chees" in the log. The computations were made by a Chinese or a Malay clerk, and checked by another clerk.

The column headed "Reduced to 73 per cent" on the log was for use if assays of the various classes (coarse, medium, and fine) of cassiterite varied from 73 per cent tin. If all classes assayed between 70 per cent and 76 per cent, weights were carried across without alteration. Otherwise, weights were reduced by table to equivalent weights of 73 per cent concentrate, and both original and reduced weights were recorded in the proper columns.

For log computations the number of "chees" in a kati were assumed to equal the number of "gantangs" in a cubic yard. (1 "gantang" = 1 imperial gallon; a "kati" is 1.33 lb.) This gave a quick translation of the "chees" per "gantang" into "katis" per cubic yard, from which the pounds per cubic yard were determined by multiplying by 1.33. This method introduced a factor of safety of 5.1 per cent into all calculations, as the assumed equivalents were lower than the actual weights by 5.1 per cent.

The chart in Fig. 4 will give an idea of the process of handling the samples and sample records.

The information given on the logs was supplemented by a rough core sample made as follows: A cubic inch of average material was taken from each sample before it left the drill. These were labeled, wrapped carefully, and placed in consecutive order in a section of bamboo a foot long. When the hole was finished the two halves of the bamboo, which had been split, were tied together, labeled, sent to the office and filed.

The labor required in handling samples is summarized in the following paragraph:

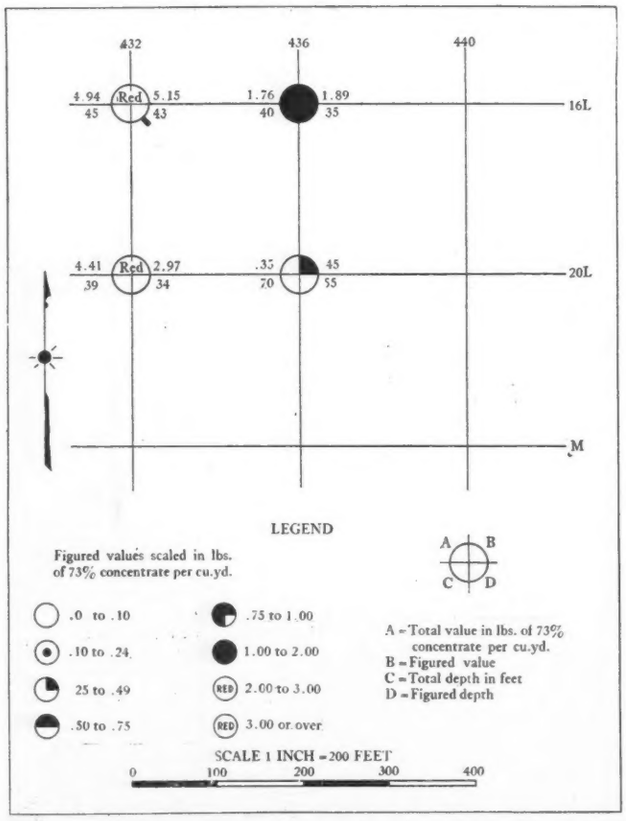


Fig. 5—Section of boring map, showing method by which values of holes were platted and indicated

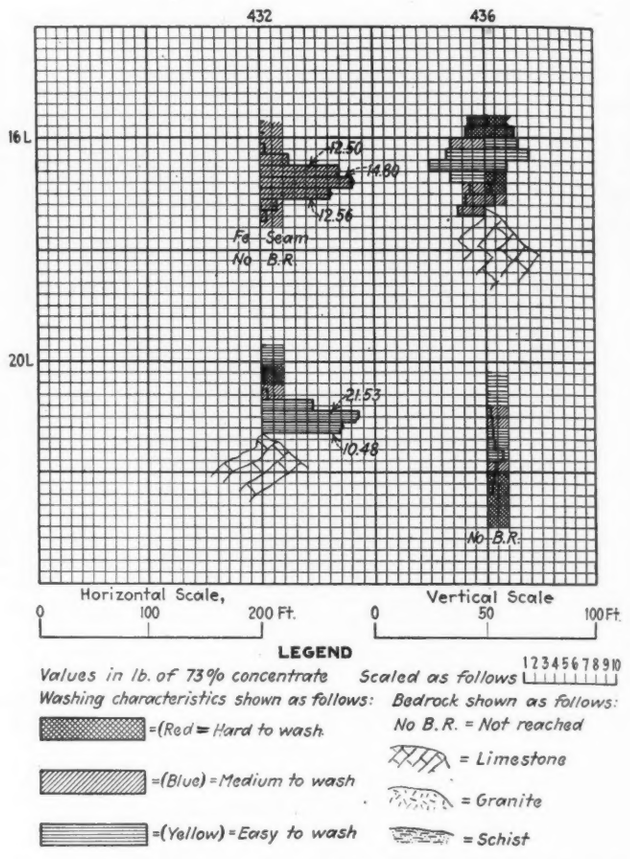


Fig. 6—Part of cross-section sheet covering boring map section shown in Fig. 5

At the drill, samples were handled by the drill foreman, who was paid $30 a month. Samples were taken to the washing plant (50 ft. to a quarter of a mile distant) by a carrier, paid 50c. a day. One washing plant served from two to six drills. Each washing plant was

Table I—Cost of Handling Samples, Ampang Examination (1920)

Cost of handling samples from two field units of three drills each, and one unit of four drills, working twenty-eight days per month. Average depth of holes drilled was 35 ft. The average drill shift, 30 ft., from which six samples were taken.

Item	Per Month: Per Drill	Per Month: 10 Drills	Per Sample: Items	Per Sample: Totals	Per Foot of Hole: Items	Per Foot of Hole: Totals
Samples	168	1,680	1	1	½	
Per drill						
Foreman	$30.00	$300.00	$0.1785		$0.0357	
Sample carrier	14.00	140.00	.0833		.0167	
Totals	$44.00			$0.2618		$0.0524
Per washing plant.	per 3½ drills					
Samples	560					
Clerk	$100.00	300.00	.1786		.0357	
Dulong washers	37.33	112.00	.0667		.0133	
Totals	$137.33			.2453		.0490
Office.	Per 10 drills					
Samples	1,680					
Motor car	$28.00		.0167		.0033	
Tin washer	28.00		.0167		.0033	
Tin weigher	56.20		.0335		.0067	
Tin wrappers	22.50		.0134		.0027	
Computers	112.50		.0670		.0134	
Totals	247.20	247.20		.1473		.0294
Total cost		1,099.20		.6544		.1308

supervised by a white man or an Eurasian, paid about $100 a month. One woman at 40c. a day was employed at the washing plant for each drill served. The office tin washer was paid $35 a month, as final washing

required more skill. In a six-hour day he washed about seventy-five samples.

Weighing and wrapping required one engineer, who was paid $225 a month, and two clerks, who were paid $45 a month. They weighed and wrapped for about two and one-half hours each day, and in this time could handle seventy-five samples. A clerk could compute or check seven average logs in a day.

Table I was made for a unit of ten drills. It was assumed that there was enough other work to fill the time of all the force.

About three-fourths of the time of the examination office was spent on the Ampang examination records. The office was organized as follows:

Office Organization and Salaries Paid

	Salaries per Month U. S. Currency
Surveying and office manager	$225
Bookkeeper	150
Filing clerk	75
Four clerks—salaries $45 each per month	180
Office tin washer	35
Total	$665

The office manager supervised the surveying, office force, and motor cars. The filing clerk saw that logs and maps were properly filed, computed results, helped with the weighing of samples, if necessary, kept office supplies in stock, and made blueprints. The clerks computed logs and plotted results on cross-sections and maps. One of them was a compass man, who was sent into the field, if necessary, to train compass men or help with the surveying.

In addition to logs, the following records were kept in the examination office: Boring maps, cross-sections, summary books, payrolls, rice records, and expense accounts. Survey records were transferred and posted, requisitions for supplies were sent in and followed up,

LEFT-HAND PAGE

Summary of Boring Results — AMPANG — Examination.

Line.	Hole.	Plan No.	Date.	TOTAL Depth.	TOTAL Val.	TOTAL D. x V.	CUT Depth.	CUT Val.	FIGURED Depth.	FIGURED Val.	FIGURED D. x V.
20 L	432	536	1/7/20	39	441	169 79	5	1300	34	297	100 81
20 L	436	536	3/1/20	70	35	24 50	15	000	55	45	24 50

RIGHT-HAND PAGE

(Values in lbs. of 73% Concentrate per cu. yd.) Line Page 34

Ft. of Karang .25 lb. or over.	Bedrock	Contractor.	Kapala.	Foreman.	WASHERS. Field.	WASHERS. Final.	Field Engineer.	Remarks.
18	Ls	Kim	Loom	Moh'd	Beal	Koh	Smith	
30	Not R	Loon	Sam	Hussin	Beal	Koh	Smith	

Fig. 7—Page from summary book, showing headings

and records and samples were filed. Bore holes were indicated on the office maps by black circles two-tenths of an inch in diameter. The total and figured value and depth of each hole were indicated graphically, using the legend shown in Fig. 5.

On the cross-section (see Fig. 6) values of samples were plotted, each small square representing 1 lb. per cubic yard. As the paper had only ten squares to the inch, values over 10 lb. were indicated by figures. (See sample G, hole 20L-432). This left the intermediate squares for results of close or check boring. The colors red, yellow, and blue denoted that the samples were hard, easy, or medium to wash.

The vertical scale was 50 ft. to the inch. The point of intersection of line and hole numbers was supposed

YUKON GOLD CO.—IPOH, PERAK
Boring Cost—Ampang Examination

	March 1920 Total	March 1920 Per Foot	April 1920 Total	April 1920 Per Foot	May 1920 Total	May 1920 Per Foot	June 1920 Total	June 1920 Per Foot	July 1920 Total	July 1920 Per Foot	August 1920 Total	August 1920 Per Foot	Total To Date Total	Total To Date Per Foot
Field Labor														
Field Supplies														
European Superintendence														
Office Expense														
Office Salaries														
Miscellaneous														
TOTAL FIELD COST														
Ipoh Office Overhead														
New York Overhead														
TOTAL COST														
	Field	Total	Field	Total	Field	Total	Field	Total	Field	Total	Field	Total	Field	Total
Number of Drills Operating														
Number of Drill Days														
Number Holes Drilled														
Average Depth of Holes														
Total Feet Bored														
Number Acres Bored														
Holes per Drill Day														
Acres per Drill Day														
Feet per Drill Day														
Cost per Acre														
Cost per Hole														
Cost per Drill Day														
Cost per Foot														

NOTE 1—All Costs are in Straits Currency $1.00 U.S.C.=2.00 Straits Currency
2—All Costs as given include all Expenditures charged to the Examination
3—All Salaries and Traveling Expenses Europeans, Engineers and Boring Foremen, paid by the Ipoh or N. Y Office which are chargeable to Examination are included in Field Costs under European Superintendence. These Items are distributed over the Months that the Men concerned were actually present on the work
4—In the above Tabulation, the Area Bored has been reduced to a Basis of One Hole to 1.8 Acres for purpose of Monthly Comparison

Costs per Acre Prospected	Acres Bored	Field Cost	Field Cost Per Acre	Total Cost	Total Cost Per Acre
Total Area Prospected					
Area Bored 1 Hole to ⅝ Acre					
Area Bored 1 Hole to 1.8 Acre					

Fig. 8—Monthly cost and summary sheet

to be at an elevation of 150 ft. above sea level. Thus a rough contour of the land as well as of the bedrock was obtained, for the hole was plotted at its correct elevation. For instance, the elevation of 20L-432 was 157 ft. and the elevation of 20L-436 was 145 ft. The horizontal scale was 100 ft. to the inch. When check holes were put down, the check values were plotted to the left of the line as shown at 16L-436A. The plotting

AMPANG EXAMINATION (Month) 1920.			
	Previously Reported	This Month	To Date
Acres bored			
Holes put down			
Average depth			
Acres developed			
Acres rejected			
Developed Ground			
Acres developed			
Average depth			
Yardage			
Average value (Lb. concentrate per cu.yd.)			
Lb. concentrate total			
Lb. tin[1] total.			

[1] Pounds tin was 71.7% of the total pounds concentrate. The concentrate contained 73% tin but 1.3% was deducted for smelting losses.

Fig. 9—Progress report form

clerks signed each log as they plotted it on either cross-sections or maps.

Summaries Kept Private

The important facts concerning each hole were entered in a summary book. See Fig. 7. Access to the summary books was allowed only to the company's engineers. When every line on a page had been filled, totals and averages were made and the page was signed by the engineer in charge of the examination.

The examination department sent three sheets with each monthly report: cost sheets, progress maps and progress reports. Each month's cost was summarized on a cost sheet, shown in Fig. 8. These sheets were on tracing cloth and were posted progressively in the examination office. The data on overhead expenses were posted in the New York and Ipoh offices and a copy of the print was mailed back to Kuala Lumpur.

Progress maps were made on a scale of 16 chains per inch. The holes put in during each month were indicated on them by small black dots. Areas worth taking up were indicated by red cross-hatching. Areas found worthless were outlined in red.

The progress reports were typewritten sheets, indicating progress and results, using the form shown in Fig. 9.

Rice Sold to Employees

During part of the examination there was danger of a rice famine. Because of this the government ruled that each company should see that no more than a specified amount of rice was used by each man in its employ. The company bought rice by the bag and sold it at cost to the various crews when they were entitled to it.

The filing clerk stocked the office with supplies and arranged to send to America for those which could not be obtained in the Malay States. Field supplies were purchased through the office by requisition.

The cost of engineering and supervision are high, due to the employment of native labor and the necessity for close watch on all the work. Wages and cost of cars are given in Table II.

Table II—Cost of Engineering, Supervision and Transportation (1920)

Twenty-eight working days per month. Eleven regular and two check drills operating. Wages of engineers include living expenses.

Item	Wages per Man or Cost per Car per Month	Total Chargeable to "Ampang" per Month (Estimated)
Chief engineer	Not available	$1,000
Two assistant engineers	Not available	1,200
Six field engineers	$250	1,500
Head Chinaman	75	65
Service car	350	260
Three engineer's motor cars	35	40
Three extra boring clerks	30	90
Total		$4,155

The approximate total cost of examination is shown in Table III. In making this table it was assumed that in 1920 one hole on the average was put in on every 1⅓ acres which were optioned. Some of the items apparently do not agree with tables previously given. This is because deductions are made for items covered in more than one of the previous tables, as, for instance, clerks computing logs.

Table III—Cost Summary (1920)

Thirteen drills operating for one month of twenty-eight days. Average depth of holes, 35 ft.; average drill shift, 30 ft. 415 acres examined a month. 10,920 ft. drilled a month. 312 holes drilled a month.

Items	Cost per Month	Cost per Foot	Cost per Acre Examined
Surveying	$181	$0.017	$0.44
Boring	3,494	.320	8.42
Sample treatment (in the field)	1,107	.101	2.66
Examination office (and sample handling in the office)	500	.046	1.21
Engineering and transportation	4,155	.380	10.00
	$9,437	$0.864	$22.73

Concluded

Improvement in Quicksilver Output Expected

Preliminary figures showing the production of quicksilver in the United States in 1922, compiled by F. L. Ransome, of the U. S. Geological Survey, gave a total of 6,497 flasks, of 75 lb. net, compared with 6,339 flasks in 1921, which was the smallest annual output in the seventy-two years of recorded production of domestic quicksilver. In 1922, California produced 3,494 flasks, Texas, 2,725 flasks, and Nevada and Oregon together 278 flasks.

In California four mines were productive, but the output from all but the New Almaden group was small. The New Idria mine continued non-productive but the old Redington or Boston mine at Knoxville, Napa County, which has lain idle for many years, yielded some quicksilver and will probably be a larger producer in 1923, as a rotary furnace has been installed. In Texas, the Chisos mine, in the Terlingua district, Brewster County, yielded more quicksilver than any other mine in the United States. The Mariscal mine, near McKinney Springs, in the same county, was also productive. Prospecting was in progress at the Waldron mine, in the Terlingua district, 95 miles south of Alpine. In Nevada the only production recorded was made from deposits in the Pilot Mountains, east of Mina, in Mineral County. The output from Oregon was practically negligible.

No important additions to known resources of domestic quicksilver were made during 1922, but the effect of the new import duty will probably be seen in a moderate increase in production in 1923.

The Marketing of Feldspar

Many Varieties Produced in United States—No Standard Grades and Specifications Recognized by the Trade

By Arthur S. Watts
Professor of Ceramic Engineering, Ohio State University

FELDSPAR is the name assigned to a mineral group consisting of a large number of members. It is essentially an aluminum silicate of the alkalies and alkaline earths. In nature the members rarely occur in a pure state, and the different members of the group have been classified with reference to the alkali or alkaline earth which constitutes the predominating base.

Feldspars may be classified according to their alkali or alkaline earth constituent into four distinct groups: (1) Potash feldspars, known as microcline or orthoclase, $KAlSi_3O_8$; (2) soda feldspar, known as albite, $NaAlSi_3O_8$; (3) lime feldspar, known as anorthite. $CaAl_2Si_2O_8$; (4) barium feldspar, known as celsian, $BaAl_2Si_2O_8$. In nature, these minerals commonly occur as intimately crystallized masses of two or more different feldspars. Some of the feldspars apparently combine and form homogeneous crystals of definite composition, whereas others are isomorphous mixtures.

Potash feldspar is found in nature in two forms—namely, microcline, which is the chief constituent of the ordinary feldspar of commerce, and orthoclase, which is less frequently met, although until recently the microcline of commerce has gone by this name. The error has, however, been of no industrial importance, because the two minerals are identically the same in chemical composition, differing only in crystalline form and in optical properties.

Microcline has the molecular formula $K_2O.Al_2O_3.6SiO_2$ and is approximately of the composition K_2O, 16.9 per cent; Al_2O_3, 18.4 per cent; and SiO_2, 64.7 per cent. Its specific gravity is 2.54; it has a hardness of 6 to 6.5; and belongs to the triclinic system. Its color is generally white, grayish yellow, yellow, or any shade of red from light rose to brick color, the red color being due to finely divided iron oxide or hydroxide. It may be green (amazon stone) in transmitted light. In thin sections it is colorless. The Na_2O content varies up to 4 per cent and that of CaO seldom exceeds 0.05 per cent. As the Na_2O content increases in a microcline the specific gravity increases, and with a soda content of 4 per cent may be as much as 2.57.

Orthoclase varies in few respects from microcline. It crystallizes in the monoclinic system, but the polysynthetic twinning that is characteristic of microcline may be submicroscopic in orthoclase and hence not apparent. It has the same specific gravity and color as microcline, and has a hardness of 6.

Soda feldspar is found in nature in two forms—namely, albite, which is the form ordinarily encountered, and cleavelandite, which is a lamellar variety of albite, differing from it only in massive structure and having the same optical and physical properties.

The molecular formula of albite is $Na_2O.Al_2O_3.6SiO_2$. Its approximate composition is as follows: Na_2O, 11.8 per cent; Al_2O_3, 19.4 per cent; SiO_2, 68.8 per cent. Albite has a specific gravity of 2.624, ranges in hardness from 6 to 6.5, and crystallizes in the triclinic form. Its color is generally white, although it may be reddish, greenish, bluish, or gray. Cleavelandite often displays a bluish tint. In thin sections albite is colorless.

The Na_2O in albite may be replaced by CaO in amounts less than 3 per cent CaO and the mineral still retain its name. When the CaO content exceeds 3 per cent, however, it is classified as a lime-soda feldspar, of which there are now recognized a series of five numbers between pure albite and pure anorthite. These form the plagioclase subgroup.

Lime feldspar is known as anorthite, and in its pure state occurs only in one form. This feldspar has the molecular formula $CaO.Al_2O_3.2SiO_2$, and contains the following percentages of these compounds: CaO, 20.1; Al_2O_3, 36.62; and SiO_2, 42.28 per cent. The mineral has a specific gravity of 2.758, a hardness of 6 to 6.5, and is colorless in thin sections.

The CaO in anorthite may be replaced by Na_2O in amounts less than 1.6 per cent. When the Na_2O content exceeds 1.6 per cent, the feldspar becomes one of the plagioclase subgroup.

Barium feldspar is known as celsian, and in the pure state occurs only in one form. The molecular formula of celsian is $BaO.Al_2O_3.2SiO_2$. The mineral contains 41.8 per cent BaO, 27.2 per cent Al_2O_3, and 32 per cent SiO_2, and has a specific gravity of 3.38, a hardness of 6 to 6.5; crystallizes in monoclinic form, and is colorless unless stained by impurities.

Aside from these four principal feldspars, there are

Feldspars—Formulas and Limits of Composition (*a*)

Name	Formula Limits		Limits of Composition					
			BaO	K_2O	Na_2O	CaO	Al_2O_3	SiO_2
Celsian	$(BaAl_2Si_2O_8)$		40.8	....	....	....	27.2	32.0
	$(BaAl_2Si_2O_8)$	2 $(KAlSi_3O_8)$	16.5	10.1	....	....	21.9	51.5
Hyalophane	$(BaAl_2Si_2O_8)$	2 $(KAlSi_3O_8)$	16.5	10.1	....	....	21.9	51.5
	$(BaAl_2Si_2O_8)$	6 $(KAlSi_3O_8)$	7.5	13.8	....	....	20.0	58.7
Microcline or orthoclase	$KAlSi_3O_8$	....	....	16.9	....	....	18.4	64.7
Anorthoclase	$(2KAlSi_3O_8)$	3 $(NaAlSi_3O_8)$	....	7.0	6.9	....	19.0	67.1
	$(KAlSi_3O_8)$	6 $(NaAlSi_3O_8)$	....	2.5	10.1	....	19.3	68.1
Albite	$NaAlSi_3O_8$	....	....	....	11.8	....	19.4	68.8
Oligoclase	6 $(NaAlSi_3O_8)$	$(CaAl_2Si_2O_8)$	....	....	10.0	3.0	22.1	64.9
Andesine	2 $(NaAlSi_3O_8)$	$(CaAl_2Si_2O_8)$	....	....	7.7	7.0	25.4	59.9
	3 $(NaAlSi_3O_8)$	2 $(CaAl_2Si_2O_8)$	....	....	6.9	8.3	26.5	58.3
Labradorite	4 $(NaAlSi_3O_8)$	3 $(CaAl_2Si_2O_8)$	....	....	6.6	8.9	27.0	57.5
	$(NaAlSi_3O_8)$	$(CaAl_2Si_2O_8)$	....	....	5.7	10.3	28.3	55.7
Bytownite	$(NaAlSi_3O_8)$	2 $(CaAl_2Si_2O_8)$	....	....	3.8	13.7	31.1	51.4
	$(NaAlSi_3O_8)$	3 $(CaAl_2Si_2O_8)$	....	....	2.8	15.3	32.5	49.4
	$(NaAlSi_3O_8)$	6 $(CaAl_2Si_2O_8)$	....	....	1.5	17.4	34.3	46.8
Anorthite	$CaAl_2Si_2O_8$	....	....	....	....	20.1	36.6	43.3

(*a*) Formulas are according to Rosenbusch, "Mikrokopische Physiographie der Mineralien and Gesteine." Authorities do not agree as to the exact formula limits, but differences are usually negligible and are not important.

many feldspars which are made up of two fluxes. Anorthoclase or soda-microcline is a feldspar in which more than one-half the potash is replaced by soda. Hyalophane is a feldspar in which part of the potash is replaced by barium. Plagioclases are lime-soda feldspars which are a group of feldspars whose members form a continuous series connecting albite and anorthite, as may be seen from the table.

The above formulas represent only the pure minerals and combinations of two pure minerals. In nature, one rarely finds a pure feldspar—that is, one containing but one alkali—in large quantity, and feldspars consisting of mixtures of but two pure minerals are comparatively rare. The manufacturer, therefore, has little use for data based on the pure minerals except as they conduce to a better understanding of the complex feldspars with which he has to deal.

The feldspars most extensively used in the industries are the two forms of potash-feldspars, microcline and orthoclase. The chemical compositions and physical properties of these two minerals are identical, and for all practical purposes they may be dealt with as one mineral, microcline, which is the form generally encountered.

In commerce the term "potash feldspar" is used in referring to any feldspar in which potassium is the prevailing flux, and even though the proportion of potassium is so low as to make the chemical composition approach hyalophane or anorthoclase, the latter names have never been employed in the industries.

As indicated in the above list, no series of feldspars occurs in nature in which the potash is replaced by lime, and if a potash feldspar contains any appreciable amount of CaO it is safe to assume that it contains an equal or greater amount of Na_2O, the two elements being introduced in one of the plagioclases, which is perthitically intergrown in the microcline.

Hyalophane is rarely encountered in commercial quantity. Barium as a constituent of feldspars is not uncommon, but rarely exceeds 0.5 per cent, and generally, if present, the proportion is less than 0.25 per cent.

It is a matter of record that potash feldspars which contain even a small amount of barium display a marked decrease in viscosity when fused, as compared with similar feldspars which contain no barium.

Mixtures of microcline and albite or mixtures of microcline and albite-rich members of the plagioclase series are really the feldspars with which the manufacturer who uses the material popularly known as "potash feldspar" has to deal.

In purchasing "soda feldspar" the manufacturer never obtains pure albite, because deposits of pure albite of commercial size do not exist. The nearest approach to pure albite which is obtainable in commercial quantity is a feldspar high in soda content and relatively low in potash and lime content.

The impression prevails among users of feldspar that "soda feldspar," or albite, is the softest member, and that "potash feldspar," or microcline, is the hardest member of a feldspar series, and that the hardness of any mixture of these two will be proportionate to its relative content of the two extremes; that is, the deformation-temperature curve of potash feldspar-soda feldspar mixtures is supposed to be a straight line, with soda feldspar as the lowest point and potash feldspar as the highest point.

The results of my study of a large number of feldspars containing both potash and soda as fluxes indicates that this assumption is not true, but in making feldspar analyses there are so many slight variables which may affect the result that the exact cause of variation in any particular property is extremely difficult to determine. However, it was noted that feldspars with a moderately high content of soda and proportionately low content of potash showed a marked tendency to deform at lower temperatures than did the relatively pure soda feldspars.

The alkali feldspars are the only ones that have industrial importance at present. The potash feldspars are used in largest quantities. They constitute the chief flux or solvent of all ceramic or clay bodies, causing a gradual vitrification which can be controlled successfully in commercial kilns. These include art and service porcelains, chinas and earthenwares, sanitary porcelains, wall and floor tiles, electrical porcelains, and chemical porcelains. They are also used in compounding glasses, glazes, and metal enamels.

The soda feldspars are used chiefly as an auxiliary flux with the potash feldspars, but predominate as a glaze flux over the potash feldspar, owing to the fact that they impart to the surface produced a superior gloss and texture.

Feldspar was marketed to the user in the ground state exclusively until within the last five years, when a few large and particular manufacturers have installed grinding machinery and are now buying the crude rocks.

Principal Producing Centers of Crude Feldspars

The feldspar consumed in the United States is mined in Maine, from Auburn southeast through Brunswick to the coast; New Hampshire, near Keene; Connecticut from Hartford south and west about twenty miles; New York, in Westchester County; Pennsylvania, in Chester County; Maryland, in Howard and Baltimore counties, and in North Carolina, in Mitchell and Yancey counties. The largest single locality from which feldspar is produced for consumption in the United States is the Province of Ontario, Canada.

All feldspar-bearing rocks are of igneous origin—that is, they have solidified from molten masses. The potash and soda feldspars are found chiefly in granites, which generally occur as vast intruded masses, and consist essentially of quartz, feldspars, micas, and hornblende. Granite masses generally contain dikes or sills of rock that are similar in composition to the granite itself, but were intruded after the latter had more or less solidified. These dikes or sills are generally pegmatite—that is, they are coarsely crystalline granite in which feldspar and quartz are the chief constituents; the other granite constituents may be totally absent or replaced by rare minerals. This pegmatite is the source of the feldspar of commerce.

When the crystallization is exceptionally coarse or the constituents of the dike are separated into distinct bands, it is sometimes possible to obtain feldspar in commercial quantity absolutely free from associate minerals. In most dikes the feldspar and quartz are crystallized too intimately to permit of such a separation, and the most that can be accomplished is the elimination of such associated minerals as are segregated or sufficiently coarsely crystalline.

Feldspar is mined by ordinary quarry methods, and after a general sorting the rejected portion is re-sorted and by "cobbing" an additional yield of marketable

rock is obtained. The crude rock is crushed in a jaw crusher or under a buhrstone chaser mill, and screened, the fines going to the pulverizing mill and the coarse material returning for further crushing. The pulverizing process is accomplished in either the ball mill, the tube mill, or the conical mill. In the United States, all grinding is done dry, whereas in Europe, where the plants grind their own feldspar, the wet process of grinding is general. (For a full discussion of grinding methods see Bulletin of Feb. 20, 1922, American Ceramic Society.)

Situation of Grinding Mills

Grinding mills are generally situated either at the railroad station near the mines, or at distributing centers of the large consumers. A list of grinding mills follows:

Bedford Mining Co., Bedford, N. Y., operating two mills at Bedford, N. Y., and grinding Westchester County, N. Y., soda and potash feldspars.

Carolina Feldspar Co., Asheville, N. C., operating a mill at Micaville, N. C., and grinding North Carolina feldspar.

Clinchfield Products Corporation, 120 Broadway, New York, N. Y., operating a mill at Erwin, Tenn., and grinding North Carolina feldspar.

Cummings, J. W., Feldspar Co., Bath, Me., operating a mill at Bath, Me., and grinding Maine feldspar.

Dominion Feldspar Co., Barnard, N. Y., operating a mill at Genesee Docks, N. Y., and grinding Canadian feldspar.

Erwin Feldspar Corporation, Erwin, Tenn., operating a mill at Erwin, Tenn., and grinding North Carolina feldspar.

Eureka Flint & Spar Co., Trenton, N. J., operating a mill at Trenton, N. J., and grinding Connecticut, New York, North Carolina, and Canadian feldspars.

Golding-Keene Co., Keene, N. H., operating a mill at Keene, N. H., and grinding New Hampshire feldspar.

Golding Sons Co., Trenton, N. J., operating mills at Trenton, N. J.; Wilmington, Del.; and East Liverpool, Ohio, and grinding Maine, Maryland, North Carolina, and Canadian feldspars.

Howe, L. W., South Glastonbury, Conn., operating a mill at South Glastonbury, Conn., and grinding Connecticut feldspar.

Maine Feldspar Co., Brunswick, Me., operating mills at Topsham and Auburn, Me., and grinding Maine feldspar.

Mount Eagle Feldspar Co., 327 Union Building, Cleveland, Ohio, operating a mill at Cleveland, Ohio, and grinding Canadian feldspar.

Pennsylvania Pulverizing Co., Lewistown, Pa., operating a mill at Rochester, N. Y., and grinding Canadian feldspar.

Products Sales Co., 32 South Calvert St., Baltimore, Md., operating a mill at Baltimore and grinding Maryland feldspar.

Rock Products Co., Nicholas Building, Toledo, Ohio, operating a mill at Silica, Ohio, and grinding Canadian feldspar.

Trenton Flint & Spar Co., Trenton, N. J., operating mills at Cathance, Me., and Trenton, N. J., and grinding Maine feldspar.

Wheeling Pulverizing Co., Wheeling, W. Va., operating a mill at Wheeling, W. Va., and grinding Canadian feldspar.

Willms, Carl, Erwin, Tenn., operating a mill at Erwin, Tenn., and grinding North Carolina feldspar.

The market for pulverized feldspar is confined to fairly well-defined areas including New York State, New Jersey, West Virginia, Ohio, and Indiana, with Trenton, N. J., and East Liverpool and Zanesville, Ohio, as the principal centers. Not more than 10 per cent of the ground feldspar is marketed outside these areas.

Annual Consumption

The market for feldspars has never been oversupplied for more than a few months at any time for the last twenty years. The annual production for a period of years is shown in the following table:

Feldspar Production (*a*)

	United States		Canada	
	Short Tons	Value	Short Tons	Value
1915	105,118	$489,223	15,455	$59,124
1917	141,924	728,838	19,642	89,826
1919	71,054	585,200	14,679	86,231
1921	111,100	700,000	30,540	223,000

(*a*) From U. S. Geological Survey reports.

Grades of Feldspar

No definite grading system has ever been established either in crude or ground feldspar. The terms No. 1 and No. 2 Spar are sometimes used in market reports, but these have only general meaning. No. 1 Feldspar is a selected grade of the product of the district. No. 2 Feldspar is a grade less carefully selected than No. 1 and generally higher in quartz and muscovite. Neither No. 1 nor No. 2 grade feldspar may contain biotite (black mica), garnet or tourmaline in amount sufficient to noticeably affect the color of the feldspar when fused. In some districts a No. 1 grade will carry no free silica, though in other districts the same grade will carry 10 or even 15 per cent quartz. Numerous attempts to reach some agreement between producers and consumers have failed, but the problem is now under consideration by a committee of the American Ceramic Society, and doubtless some system of grading will be offered in the near future.

A grade known as dental feldspar has been produced and marketed for many years, but the consumption amounts to only a few tons per year and need hardly be considered. It is obtained by carefully hand sorting a quantity of choice crude feldspar and selecting the perfectly clear crystals free from all foreign material. This is carefully barreled and sold to the manufacturers of artificial teeth.

Another grade sometimes referred to in reports is that known as soap feldspar. This is purchased by a large producer of scouring soap. It consists of feldspar rock absolutely free from quartz, but containing mica in such quantity as to condemn it for the ceramic market.

A few feldspar grinders are producing what they call a glaze feldspar. This is a natural or artificial mixture of potash and soda feldspar in about equal proportions, in which the soda feldspar is slightly in excess.

There is no basis for a grade known as glass makers' or enamelers' feldspar, as both of these industries are demanding as high-grade potash feldspar as they can secure. The fact that their product is completely fused, however, may cause them to accept or even prefer a coarser-ground product than would be acceptable to the clay-working industries.

The consumption of ground feldspar is practically uniform throughout the year, and as the mining is regulated in many sections by weather conditions, this necessitates excess production of crude feldspar during the summer months in most localities.

There is practically no market for feldspar discolored by iron or iron-bearing minerals. The manufacturers of clay wares demand exceptionally finely pulverized product, not more than 6 per cent residue on a 200-mesh sieve. In the glass and enameled metal industries, the requirements are less severe, many consumers accepting material provided it passes 100-mesh sieve.

There are no standard specifications governing the sale of feldspar. The general requirements are covered, however, by the following specifications:

I. The Sample

In sampling car-load lots, equal amounts shall be taken from at least five different points in the car, no two samples being taken within five feet of each other.

In sampling from a bin, five separate samples shall be taken from different portions of the bin and not more than two from the same level. The total sample shall be not less than ten pounds. The samples shall be thoroughly mixed on a smooth surface, divided in halves, and one-half spread evenly over the other half. Repeat this operation five times. The mixed sample shall then be quartered and two quarters not adjoining rejected. The remaining quarters shall be mixed, as described above, five times, quartered as before, and two quarters rejected. The remaining sample shall weigh more than 2.2 lb. (1 kg.) and shall be placed in a tight receptacle, and marked with an identifying number or with the name of the material, car or bin number and the date on which the sample was taken.

II. Chemical Composition

1. Feldspar sold as potash feldspar shall contain not less than 9 per cent K_2O, and not more than 3 per cent Na_2O and not more than 1 per cent CaMgO, and the sum of the potash and soda contents shall not be less than 12 per cent.

2. Feldspar sold as soda feldspar shall contain not less than 7 per cent Na_2O, not more than 3 per cent K_2O, and not more than 2 per cent CaMgO, and the sum of the potash and soda contents shall be not less than 10 per cent.

3. Feldspar sold as mixed or blended feldspar shall contain not less than 11 per cent total potash and soda content.

III. Physical Properties and Tests

1. Color. The feldspar when formed into a standard-sized cone and deformed in a closed sagger or muffle shall show a uniform white color and no specks or spots either on the surface or on the interior of the cone when broken.

2a. Fineness of Grain. One hundred grams of the sample, after being dried to constant weight at 105 deg. C., shall be tested for fineness of grain according to the process set forth in paragraph 2b, and the residues on the various standard sieves shall not exceed the maximum totals as set forth in the following table:

Standard Sieve Mesh per Linear Inch	—Residues in Per Cent— Each Sieve	Maximum Total
65	0.25	0.00
100	0.25	0.50
150	1.75	2.25
200	3.75	6.00
250	5.00	11.00
300	7.00	18.00

All percentages are calculated on dry basis.

2b. Method of Making Fineness of Grain Test. The 100 gm. of dry sample shall be transferred to the sieve and placed over a sieve pan which fits closely enough to prevent loss by slopping. The pan shall contain sufficient water to reach within not less than ¾ in. or more than 1¼ in. from the pan. The sieve and pan shall be vibrated or shaken in such a manner that the water in the pan is splashed on the screen from below so as to wash the powder about and cause the material that can pass through the sieve to pass into the pan below. This treatment shall be continued until no more material can be removed. The residue and the sides of the sieve shall then be thoroughly washed with water by means of a laboratory wash bottle.

In the washing process no artificial means, such as the use of shot, or rubbing with the finger, shall be employed to force material through the sieve.

The order of sieves used shall be as follows: Wash the sample on the 300-mesh sieve to remove all fines, as this facilitates an accurate classification of the coarse material. The material passing this sieve may be concentrated by evaporation to dryness and weighed or may be immediately thrown away, and its amount determined by difference. The residue on the 300-mesh sieve is transferred to a 65-mesh sieve and washed as described above. The material on the sieve is dried and weighed. The material passing the 65-mesh sieve is transferred to a 100-mesh sieve and washed, and this process continued on the 150-, 200-, 250-, and 300-mesh sieves, in order named, the residues on each being dried and weighed.

3. Moisture Content. Unless otherwise specified, the purchase price shall be based on moisture-free material, and the moisture content shall be determined as follows: 50 gm. of the sample (Paragraph I) is carefully weighed out as soon as the sample is taken and placed in an oven where a temperature between 105 and 110 deg. C. is maintained, with proper ventilation. The drying period shall be twenty-four hours and the loss in weight at the end of that period shall be reported as percentages of the dry weight.

4. Fusion Behavior. Test cones of the material shall be made of standard dimensions—i.e., 2¾ in. high by $\frac{3}{16}$ in. diameter across base of one face. Cones of similar dimensions shall also be made of a mixture of 75 per cent by weight feldspar being tested and 25 per cent by weight of flint of standard specifications. The use of an organic bond as dextrine or gum arabic, is permissible to insure the cones retaining form prior to fusion, but such added material must burn out completely and not affect the color of the material.

The fusion behavior of the different feldspars shall be as follows:

(a) Feldspars sold as potash feldspars shall fuse with or prior to Standard Orton cone 8. The mixture of 75 per cent feldspar and 25 per cent standard flint shall fuse with or prior to Standard Orton cone 9.

(b) Feldspars sold as soda feldspars shall fuse with or prior to Standard Orton cone 7. The mixture of 75 per cent soda feldspar and 25 per cent standard flint shall fuse with or prior to cone 8.

(c) Feldspar sold as mixed or blended feldspar shall, if it contains more than 4 per cent soda, fuse prior to cone 7. The mixture of 75 per cent mixed or blended feldspar and 25 per cent standard flint shall fuse prior to cone 8.

5. Shipping Conditions. All material purchased under these specifications shall be shipped in clean closed cars.

IV. Rejection

The purchaser reserves the right to reject any portion or all of the material which does not conform to the above specifications in every particular and to return the rejected material to the manufacturer or seller for full credit at price charged f.o.b. point of delivery specified by the purchaser. If the material is to be replaced, a new order will be entered at prices, terms, and conditions acceptable to the purchaser.

Feldspar is shipped in bulk in carload lots. A common and questionable practice is to merely clean the car carefully and dump the pulverized feldspar directly on the floor. Within the last few years some buyers insist that the car be lined with paper. Less than carload lots are shipped in cloth sacks, which are charged for, but are returnable for credit. All prices are quoted f.o.b. cars at mill.

No basis for determining the value of feldspar based on its actual composition has been established, and at present a feldspar with 10 per cent potash or soda has the same market value as one containing 12 per cent. Much interest is manifested in the subject, however, and no doubt some radical changes will result within the next year or two.

Feldspar is generally sold in carloads directly from the pulverizer to the consumer, although a few mills are marketing their output through a single broker or selling agency. Less than carloads are handled by brokers and supply houses. No uniform terms of settlement prevail, but general practice is "thirty days net."

The price of pulverized feldspar per short ton has varied considerably during the last ten years. In 1913 the select, extra fine ground feldspar sold for $13, approximately, per ton, f.o.b. cars at mill in car lots. The cheapest grade, poorly ground, sold at about $10. In 1916 the price had advanced about $2 per ton on all grades. In 1918 the price had reached $20 for first grade and $15 for poorly ground and stained.

The Future of the Low-Grade Gold Mine

The Yellow Aster, at Randsburg, Calif.—Amalgamation—Bulk Leaching —Time Element in Cyanidation

BY A. W. ALLEN
Assistant Editor

A SILENT MILL is a depressing sight; when alongside a great mine, even though of low grade, it is sometimes a reminder of the high cost of living and an unimaginative method of thinking. A visitor to the Yellow Aster property, near Randsburg, Calif., might recall the romantic circumstances attending the discovery of the mine, in 1895. The absence of appreciable industrial life there at present hints at errors of judgment and lack of experience that, seemingly, have proved fatal to the continuance of operations.

The early history of this famous mine shows that Dr. Rose L. Burcham took up the practice of medicine to obtain the wherewithal to grubstake her husband, C. A. Burcham, in a mining adventure on the Mojave desert. With Burcham were John Singleton and F. M. Mooers. It was agreed that the medico was to furnish funds to permit the continuance of a prospecting campaign for two years. This was in 1893. In April, 1895, when nearing the expiration of the allotted period, a discovery of gold was made by Singleton, who had been reading "The Yellow Aster," the title of the novel providing an appropriate cognomen for the new mine.

Early operations were simple but effective. Rich ore was crushed by hand, amalgamated, and retorted. The partners, thanks to the foresight and influence of Dr. Burcham, stuck together. A 30-stamp mill was erected in 1899; another, of 100 stamps, electrically driven, in 1901. The two units ran continuously until 1913, when the older and smaller one was retired. The 100-stamp mill operated for about sixteen years, crushing approximately 450 tons per day. Sundry changes were proposed in 1917, which involved a new program of mine development and operation, and an alternative scheme of treatment, whereby an elaborate arrangement of crushers and screens was adopted in order to eliminate as much waste as possible and thereby to raise the grade of the ore milled. Optimistic reports were current early in 1918 anent future prospects. It was maintained that the new crushing plant would handle a large amount of ore, experiment having proved that much coarse material could be rejected as waste by screening. The fine product was found to carry almost all the gold, so that it was anticipated that a mill feed would be provided of such grade and character that the output from the mine could be increased considerably. After extended trials, however, it became apparent that mining or metallurgical modifications, or both, had not been in the right direction. The result, unfortunately, was the suspension of operations late in 1918, since which time only an insignificant output has been maintained, due to the effort of leasers, who, in "picking the eyes" out of the mine, have reduced proportionally the amount of normal-grade ore available for future milling operations.

Over the technical reasons for the failure the veil has been drawn. The company, maintaining that the property was badly handled during the latter part of its existence as a producer, refrains from the publication of details of the operations during 1918, although such data would be most instructive. The mine is there, with an estimated reserve of over 6,000,000 tons of ore averaging $1.77. Electric power at reasonable rates, water, and an ideal plant site are available. The average grade of the ore is low—that much has to be admitted; but is it too much to hope that modern mining methods and improved metallurgical knowledge, particularly in regard to the economical handling of material, may together point a way to the reopening and profitable exploitation of this great mine? A statement of lowness in grade should not act as a deterrent to further interest in the proposition. Metallurgical advance during recent years has centered around the low-grade mine, not around the bonanza that can afford a high operating expense. The gold-mining industry owes much to the perseverance of its pioneers; and no small degree of credit and praise is due to Dr. Burcham, the sole survivor of the original Yellow Aster partnership, for her foresight and sane outlook, for her energy and business acumen, which resulted in the augmentation of the nation's output of gold between 1898 and 1917 by about $9,000,000—all from the Yellow Aster mine.

Metallurgical practice at this property has been simple. Amalgamation was utilized from the first, an average recovery of about 80 per cent being made. In 1916, additional amalgamating surface was provided, whereby an improved extraction followed. The results of mining and milling during 1918, after the new scheme of operations was initiated, as before mentioned, are not available; but the reticence on the part of a company that had previously been frank in this respect can only be interpreted as an evidence of disappointment.

AMALGAMATION VS. CYANIDATION

It is not always wise to make comparison, but it is permissible to mention that the mining problems at the Yellow Aster are no greater than those that have been solved at many other low-grade mines. Large-scale operation is essential to low cost and economic success. As to milling and metallurgy, it is pertinent to note that sorting can be performed without the expensive re-elevation of rock that characterizes the new plant. Advantage might well be taken of the fact that an ideal mill site and ample elevation has been provided by nature.

Amalgamation of low-grade ore involves comparatively fine crushing, which is expensive and justified only when the recovery is almost complete or when a part of the cost can be offset by subsequent recovery by wet-chemical methods. The gold in the Yellow Aster occurs in faults in the granite and in small quartz veins; the fact that the loss after ample plate amalgamation has reached about 50c. per ton indicates fineness. The improved extraction gained by increasing the plate area substantiates this; it disproves the opinion that the gold is occluded to any considerable extent in the rock.

The scope for amalgamation in the treatment of a

gold ore lies almost entirely in its value as a simple method of impoverishing the pulp before cyanidation is begun. By the adoption of a large plate area it may be possible to amalgamate a gold ore so that a fairly low residue is obtained. Thus, at the Boundary Red Mountain mine, in Washington, a recovery of 90 per cent is made by plate amalgamation after stamp milling, classification of the tailing, regrinding and re-amalgamation of the sand, and barrel amalgamation of the slime. In the handling of a high-grade ore there is obvious wisdom in adopting amalgamation; but it would seem that a line of demarcation should be recognized at which amalgamation should be stopped and cyanidation begun; otherwise the residue may contain too much gold to lose but not enough to recover by re-treatment. The net economic result of the treatment of an average or high-grade ore is usually better, and the net loss is usually lower, if amalgamation-cyanidation is adopted. The beneficial influence of efficient amalgamation in such cases needs no emphasis. The results at the Homestake are well known. The Canadian record, at the Dome mine, of a recovery of 97.7 per cent from 247,000 tons of ore valued at $4.272, shows a loss of only 10c. per ton, in the residue, thus indicating the *ultima thule* of successful metallurgical result. On the Rand, after coarse crushing, an 18c. residue is obtained from ore assaying $6; in India, at the Mysore mine, a combination amalgamation-cyanide treatment is successful in obtaining a 20c. residue from a $12.84 ore.

Problem of the Low-Grade Mine

With an exceedingly low-grade ore, however, it is obvious that there is no economic possibility of successfully adopting cyanidation after standard amalgamation treatment. What, then, can be done with the 50c. residue? At the Yellow Aster it awaits attention, but the expense of mechanical handling, reduced to almost nil when current treatment is practicable, is such that estimated profit approaches the vanishing point when re-treatment is considered. Further, wet milling involves a segregation of fine from coarse; the mixing and bulk treatment by gravity percolation of all of the product is usually impracticable, on account of fineness of crushing in the battery; the separate treatment of slime involves a comparatively heavy initial expense and operating cost. All these considerations will serve to divert attention to the bulk treatment methods recently perfected in connection with the handling of low-grade copper ores.

One of the cheapest of commodities is time. Although, on account of first cost and relative complication of apparatus, prompt treatment is essential when an ore is ground so fine that it must be kept in suspension until discharged as residue, gravity-leaching operators are not so circumscribed. Estimates show that a six-year heap leach at Bisbee will result in the recovery of about 70 per cent of the copper, which is mostly in large pieces of exceedingly low-grade ore. Has sufficient attention been paid to the time element in the cyanidation of gold ores? Now that so much is known as to the reason for the decomposition and loss of cyanide by exposure of solution, is it not reasonable to assume that the period of contact might be extended far beyond the usual limits? The first cost of plant and the expense of percolation are so low that an almost inappreciable daily extraction would justify the change. The Crowe modification has done much to make practicable the precipitation of gold from low-grade solutions, but the extension of the time of leaching would not necessarily mean the handling of a larger amount per ton treated.

Bulk Cyanidation Suggested

Although efficient sorting appears justified at the Yellow Aster, it does not seem to me that amalgamation is the ideal process for so low grade a material; the cost of milling would prove too high. All-sliming cyanidation, of course, is out of the question, on account of capital cost of plant and high operating expense. There remains only the consideration of mass leaching, with cyanide solution, in large unitary charges, of a product reduced to such a size that a profitable extraction of gold is practicable by gravity percolation. The economic feasibility of such a process depends on the point at which crushing can be stopped and satisfactory results obtained. Is the gold in the Yellow Aster ore freed after comparatively coarse crushing, say to ¼ in.? If so, the idea should be considered. The leaching of dry-crushed and unclassified material was practiced with considerable success in many of the earlier cyanide plants and on ore in which the gold was fine and made available by comparatively coarse crushing, in spite of the fact that no machine was available at that time that could be depended upon to deliver a product suitable for bulk-leaching operations. There seems to be a consensus of opinion that the gold in Yellow Aster ore is not in the hard rock, which, in leaching operations, would act as a medium of support for the finer particles, thus permitting even percolation of the liquor through the mass.

The future of the gold-mining industry in the United States depends to a large extent on the economical exploitation of low-grade deposits such as the one at Randsburg. It seems to me that the metallurgical problem may be approached by a consideration of a process involving (1) primary crushing, (2) sorting, (3) secondary crushing to a comparatively coarse mesh, (4) delivery of the dry-crushed ore to vats, (5) preliminary washing, if necessary, to remove soluble refractories, and (6) leaching with cyanide solution. The initial cost of the extra plant needed, to treat large unitary tonnages, would be comparatively small; cost of power, repairs and renewals, and labor would be low. A heavy expenditure with such operations usually occurs in connection with the disposal of residue. At the Yellow Aster it is difficult to exaggerate the value of the mill site available; the disposal of leaching-plant residue should be practicable at a minimum of expense and with a minimum loss of water.

Bulk leaching of dry-crushed ore was practiced so successfully in many parts of the world that it will not be out of place to recall the results obtained at a typical plant. The Wasp No. 2 in the Black Hills may be taken as an example. Rolls were used to crush the ore to ¼ in.; it was then delivered by belt conveyor to 488-ton vats, the material being distributed by hand. Ordinary cyanide treatment followed, the residue being discharged through bottom doors. The ore averaged about $2 per ton. Mining cost about 50c., milling about 70c., and general expenses about 5c. per ton. The profit ranged from 50 to 75c. per ton, in spite of small-scale operations, the absence of suitable crushing machines and labor-saving appliances for the distribution and discharging, respectively of ore and tailing, and the lack of development in the technique of a phase of

cyaniding that has since been adopted and improved for the extraction of soluble copper salts from low-grade ore. Recent developments at Chuquicamata and Ajo should furnish valuable suggestions to those concerned with the problem of beneficiating a gold ore of a grade too low to justify the expense of excessive comminution and complicated treatment.

It may be suggested that a visiting engineer is unwise to make a tentative recommendation in regard to the economic extraction of gold from an ore without even an elementary first-hand knowledge of its general characteristics or of its probable behavior when treated by wet-chemical methods. In the present instance, a rebuke would carry weight, for it is improbable that the Yellow Aster ore would act in the same way as did the ores from the Wasp No. 2 or any other of the many gold mines where the leaching treatment of dry-crushed material has been found economically practicable, although seldom an ideal process from the metallurgical standpoint. However, in consequence of inquiries, I have come to the conclusion that such a method has not been considered by those in control of the technical work at the Yellow Aster, and the suggestion is therefore made in the hope that further discussion might lead to experimentation and research, the cost of which would be small.

High-Grade Asbestos Deposits Found in Transvaal

One of the most interesting developments in connection with Transvaal asbestos is taking place in the Barberton district, near Kaapsche Hoop, where several promising occurrences are being exploited, according to an article on Southern Africa's asbestos deposits in the Feb. 3 issue of the *South African Mining and Engineering Journal*. Chief among these are the occurrences on the farm Joubertsdal, where the Amianthus Mines, Ltd., are developing what appears to be an extensive and valuable series of chrysotile occurrences. The Amianthus Mines Co., although it has only engaged in serious mining operations for about fifteen months, is stated to have large quantities of asbestic rock in sight.

The asbestos at Kaapsche Hoop is said to be unsurpassed the world over, while the proportion of fiber of spinnable length is unusually high. Large quantities are found in which the fiber is over one inch long; fiber three or four inches in length is common, and specimens showing a length of seven inches and more have occasionally been found.

Four or five months' continuous working earlier in the mine's history showed 27.21 per cent fiber over one inch long. When it is realized that the spinnable limit can be taken at about three-quarter inch and that the spinnable proportion of the entire asbestos output of Canada (which, in 1915, supplied 75 per cent of the world's production) only amounted to 4 per cent, while fiber one inch long accounted for only 1.4 per cent of the whole output, the significance of these figures is apparent. There is a large market for fiber under the spinnable length in the manufacture of tiles and sheets for building purposes and for various other purposes. The Quebec Government Engineer has expressed the opinion that 1 per cent of asbestos represented an average of all rock extracted and was the limit of profitable working; a 2 per cent extraction being advantageous and above 4 per cent exceptional. A great deal of the rock now being extracted at Joubertsdal will give a return of from 30 to 40 per cent asbestos, some actual figures being: 10 per cent, fiber ½ to ¾ in.; 40 per cent, fiber ¼ to ½ in.; 50 per cent, fiber ⅛ to ¼ in.

Another notable feature is the fact that it occurs in regular parallel seams instead of in a network. Faces have been exposed in the mine showing an alternation of asbestos and serpentine as regular as ruled paper. As a concrete example, may be taken a face having a vertical thickness of seven feet, packed with seams, having 15 per linear foot and increasing to 30 per linear foot, lower down, consisting roughly of 40 per cent asbestos and 60 per cent rock. The regularity of the seams and the extent to which they have been traced —about three miles along the strike—afford evidence of the fact that the Joubertsdal occurrence is probably unique in the history of asbestos mining, and it will undoubtedly form a valuable addition to the mining resources of the Barberton district.

Mine Doors, Their Construction and Use

The U. S. Bureau of Mines has recently issued a bulletin on fire and ventilation doors in metal mines (*Reports of Investigations*, Serial No. 2,426), the suggestions given being summarized as follows:

1. Mine doors and their frames should be substantially constructed, should be covered with roofing iron, or otherwise fireproofed, should be tight, and always should be kept in repair.

2. Doors should close automatically after passage of men or cars and should have a latch or other positive means of keeping them closed, even though ordinary pressure on the outside of the door becomes pressure on the inside, a situation likely to occur at a time of fire.

3. Every main air course, whether shaft, incline or level, should have in place either within itself or in all the openings leading from it, a system of doors such that in case of emergency the entire shaft, incline, or level opening can be quickly isolated from other parts of the mine. This is especially important as to downcast or intake timbered shafts, inclines, or level air courses. Doors should be provided for *all* openings leading from main air courses (both intake and return), and when at ordinary times there should be free flow of air, the door should have a sign denoting that it is to be closed only in case of emergency (if possible, giving the exact contingency under which the door should be closed).

4. All doors, but especially those for fire purposes, or for use in exits between mines, should close flush against the face of doorframe instead of in a groove within the frame; this is to prevent sticking of the door or inability to open or close it if there should be deformation of the door frame from ground movement or swelling of the door or frame.

5. Where there is necessity for frequent opening of doors controlling main air currents, or where such doors must remain open for long periods, it is advisable to have two or more doors placed such that when one must be open, one or more may be closed, to prevent loss of air.

6. All employees should be educated and trained to respect doors and especially to close those which are supposed to be closed. It is advisable to have on each door a sign such as "Keep this door closed," or "Close this door in case of fire in main shaft," or other sign applicable to the specific condition existing at each door. Any employee failing to close a door which should be kept closed, or one who deliberately or carelessly breaks a door or its frame, should be disciplined even to the extent of discharging him.

7. It is extremely desirable that all mines be divided into air splits by doors or other means, so that a fire in any one split will be held separate from all other splits, and by manipulation of doors, the fire itself isolated and controlled. In ordinary times, this system facilitates the distribution of air currents to the places where men are working.

A Mining Reconnaissance From Mazatlan

The Important Producing Mines of Sinaloa, Mexico—Geological Features of the Region—Similarity to Zacatecas, Pachuca and Guanajuato—Promising Prospects at Panuco—Copper and Lead at Picacho—A Gold District That Resembles Oatman, in Arizona

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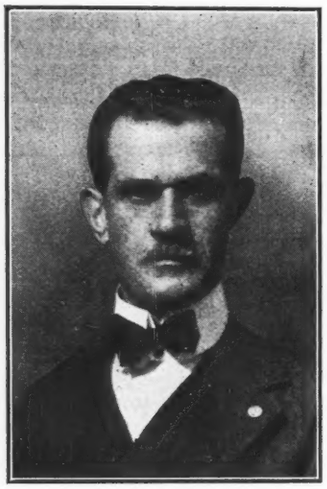


F. D. Pagliuchi

THE MINING INDUSTRY of the State of Sinaloa is not as old as that of Guanajuato, Zacatecas, or Pachuca, yet the state's mineral resources are probably as large and varied as those of any other state in the republic. Lack of roads and transportation, and the recent turbulent political and industrial conditions in the country have held back its development. Apparently there is hope for a restoration of law and order, and once they are firmly re-established, Sinaloa should become one of the great mineral producers of Mexico.

Paradoxical as it may seem, the laxness of law enforcement prevalent in the last few years instead of retarding has helped in developing the mining industry of the state. The anomaly is explained by the fact that under the Diaz regime and the mining laws of the period the cost of staking a fairly adequate mining claim ranged from $100 to $500, a fabulous sum for any Mexican miner or peon. In the last few years the miner has been able to hunt and work surface ores unmolested, with the result that many new ore deposits have been discovered, and much more ore has been shipped from Mazatlan than when the law was strictly observed. There are many important producing mines in the State of Sinaloa. Among the gold mines are:

San Jose de Gracia — This mine is owned by a Mexican company and has a production totaling several millions of dollars. It still operates, the ore averaging about $30 per ton.

Calabacilla—This is owned by an American company and produces ore averaging from $15 to $18 per ton.

Potrero—This mine is owned by a Los Angeles company; it produces ore averaging from $15 to $18 per ton.

Among the silver-gold mines may be mentioned:

Palmarito — This is owned by the Palmarito Leasing Co., and produces ore averaging about $9 per ton.

Guadalupe de los Reyes—This is owned by a Spanish-Mexican company. It is an unusually rich and highly remunerative mine and has the advantage of cheap hydraulic power. The vein is large and averages about $30 per ton.

Candelaria—This mine is situated on the border of Durango and is owned by the Candelaria Mining Co. It produces a large tonnage of low-grade ore.

San Louis—This is owned by Haggin & Hearst, of San Francisco: a rich mine with a large vein averaging about $20 per ton.

The Panuco Group of Mines—This group of mines, I believe, is the richest in the State of Sinaloa. It is owned by a Spanish-Mexican syndicate. From its discovery up to the present only ore running more than $30 per ton has been mined. The lower grade was milled and the richer has been shipped to the smelter. The mines have in sight a large tonnage of ore averaging between $5 to $6. With the addition of the richer ore the average of the total ore mined could easily be brought to about $10 per ton. In my opinion a daily production of about 500 tons could be secured. Little timbering is required, so that if power was produced from the Baluarte River, where a power site exists, I estimate that ore could be mined and milled for about $3 per ton. This would insure a good profit. At the time of a visit that I made recently the mines were

Mazatlan, in Sinaloa, Mexico

producing and treating about 1,000 tons per month, from which was obtained two tons of silver and 496 oz. of gold. In addition to this bullion, 10 to 15 tons of high-grade ore averaging from $500 to $1,000 per ton was shipped monthly.

El Tajo Mines—The Tajo mines, which are the oldest in the state, are situated about 40 miles southeast of Mazatlan. They are owned by the Bradbury Estate, of Los Angeles, and have a production record of about $50,000,000. The first method of treating the ore was by pan-amalgamation. This process failed completely on ore averaging $7 per ton. Subsequently, at a cost of about $500,000, a modern power plant, cyanide plant, and a 60-stamp mill (since replaced by two Marcy mills) were erected. The ore now treated averages from $7 to $8 per ton, and a fair profit is won.

Protectora and Duende Are Promising Silver-Gold Properties

Among new prospects which give promise of developing into mines are the Protectora and Duende groups of silver-gold mines. These are situated near Santa Lucia, in the Panuco district, about 47 miles from Mazatlan. The surrounding country is well timbered. The principal tree is a large-leaf oak. Other tropical hard woods well adapted for mining purposes also grow in the locality. Water for domestic use is plentiful. By damming certain steep canyons in the vicinity, water could be stored, and abundant power could easily be developed.

Rosario was my headquarters and starting point, and I can accordingly record some of the geological features of the country between Rosario and the different districts and prospects that I examined. Rhyolitic tuff, agglomerates, and rhyolite were observed between Rosario to Aguacate. From Aguacate to the foothills, rhyolitic tuffs occupy the valley of the Rosario River. The undisturbed stratification of the tuffs shows that they were formed in still water, indicating that previous to the Tertiary period the Rosario valley was either a lagoon or an estuary of shallow salt water, similar to the present marismas of the coastal plain.

General Geological Features

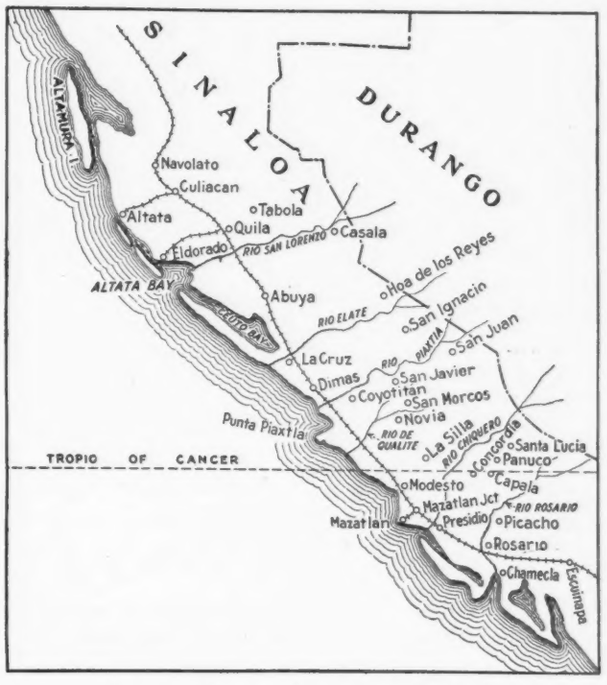
As the foothills are approached the tuffs are succeeded by a rhyolitic agglomerate composed of round pebbles cemented together by volcanic mud, denoting either a lacustrine or seashore line. In ascending the first hill remnants of rhyolitic sheets and sills were observed. From this elevation to the Copala-Butters Mines the entire country is overlaid by Tertiary volcanic eruptives. On the road and in the vicinity of the mines the first indication was observed of the underlying country rock, a greenish-blue andesite, exposed at this point by erosion. Two veins were also noticed where they cut across the road leading to Panuco.

In approaching Panuco, the country rock appears to be more oxidized and decomposed, indicating stronger mineralization than at Copala. Several veins were observed extending across the road. The Santa Rosa vein, which has produced and is still producing from rich oreshoots, is one of these veins. Two bosses of granite occur between Panuco and Santa Lucia. The undisturbed overlying rhyolite proves the pre-Tertiary origin of the granite.

Santa Lucia, characterized by castellated domes, high peaks, and deep ravines, appears to have been the center of pronounced igneous activity. Here also, as in the Panuco district, the principal underlying rocks are andesite and andesitic breccias.

The Tertiary was a period of intense volcanism, of domal uplift, mountain building, folding, and fissuring. The large amounts of gaseous and water vapors emanating from the magmas were without doubt important agents in forming mineral deposits. Tectonic disturbances which originated after the formation of the andesite gave rise to two systems of veins; one of these extends north to south, and the other has a northwest course.

An important point in favor of the district is the similarity of its formations to those of the well-known districts of Zacatecas, Pachuca, and Guanajuato. Espe-



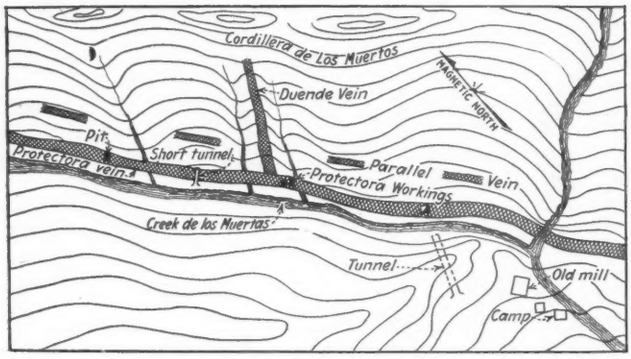
Map showing southern part of Sinaloa

cially does this similarity apply to Guanajuato. The veins in the Santa Lucia district are as large and as persistent, both in length and depth; their strike is from north to northwest, and the dip is with the mountain slope. The vein filling, as in Guanajuato, consists of brecciated country rock cemented together by white, gray, and amethystine quartz. The only difference that I observed between the Guanajuato and Panuco veins is the absence at Panuco of an oxidized zone containing gossan and metallic silver, and below this the silver chlorides, bromides, and iodides, such as cerargyrite, bromyrite, embolite, and iodyrite. However, the zone of rich bonanzas of silver sulphides at Panuco has been worked to a depth of over 900 ft. and still continues in depth. At the time of my visit one of the richest oreshoots ever found in these mines was opened at the 820 ft. level. I took a sample of ore from the richest part of the vein, which proved to contain argentite and which assayed 17,380 oz. silver and 362 oz. gold per ton.

Another geological parallelism of importance is the striking similarity of the geological and mineralogical formation of the Protectora and Duende mines to that of the Santa Rosa, the richest mine of the Panuco group. At the Protectora and Duende the veins are large and persistent, the former being traceable on the surface

for over 3,000 ft. (See sketch.) The vein filling, its mineral composition, and the country rock (andesitic breccia) are virtually identical.

The Protectora vein, at the place where mining operations were in progress at the time of my visit, is about 30 ft. in width. The vein has a northwest strike and dips to the southwest. With the exception of about 60 ft. of barren quartz near the hanging wall, the remaining portion of the vein is composed of brecciated country rock re-cemented together by white and gray quartz. The strongest mineralization is in the vicinity of the footwall, where two short tunnels have been driven. The first or lower tunnel has attained a length of 58 ft. It is in oxidized and decomposed country rock for the most part, and at the face signs of ore appeared. The upper tunnel has attained a total length of 90 ft. The first ore was encountered on the east wall at a distance of about 34 ft. from the portal. About 60 ft. from portal in the middle of a small stope, on the floor, near its west wall, occurs about four feet of ore, which is also visible on the roof of the stope. A sample taken across a 4-ft. width assayed 73 oz. of silver and 1.26 oz. of gold per ton. The ore mined from this oreshoot was taken to a patio, where it was cobbed and hand-sorted. Two grades of ore were obtained from the sorting, a shipping ore assaying from 300 oz. to 600 oz. of silver and from 2 to 3 oz. gold per ton, and a second grade,



Sketch map of Protectora and Duende properties

left at the mines, which assayed approximately $10 per ton.

From these workings the vein exhibits a strong outcrop, and can be followed to the summit of the hill and also on the north slope to its intersection with a creek bed, at which place it is slightly faulted, probably by the Duende vein, which intersects and displaces the Protectora vein for a short distance. Only a few prospecting holes have been sunk on the vein.

Bad Management Handicapped Early Operations

The Duende group of mines joins the Protectora and was worked profitably about twelve years ago. Lack of mining knowledge, poor and expensive transportation, and antiquated pan-amalgamation for the treatment of the ore were the cause of the suspension of operations.

A strong vein exhibiting the same characteristics as the Protectora vein occurs on both sides of a gulch. This vein, in my opinion, joins the Protectora vein at a point about 400 ft. north of the Protectora upper tunnel. Two tunnels were driven in the gulch, one in a westerly direction for about 100 ft. and the other in an easterly direction for a distance of about 400 ft.

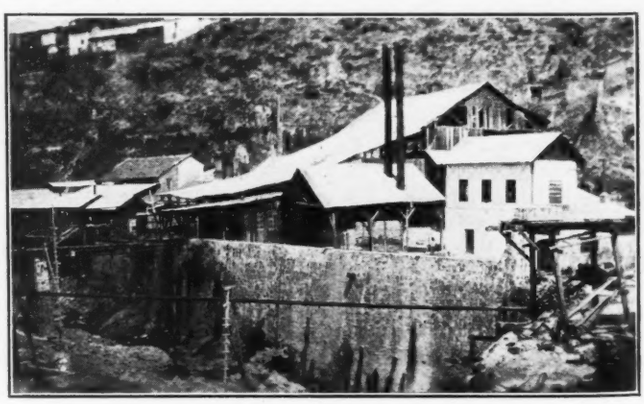
A limited amount of stoping was done and the ore

Santa Rosa mine at Panuco

extracted was transported on mule-back to a small mill two miles distant. About 150 ft. from the portal of the easterly tunnel the vein turns eastward. The turning was either not observed or was disregarded, with the result that the continuation of the tunnel is in barren ground. At the time of my visit several *gambusinos* had followed the vein to the east, picked up its continuation, and were extracting rich ore. The next workings are situated about 1½ miles south of the Duende claim and consist in a 60-ft. shaft, and a tunnel driven to meet the shaft. The tunnel was never completed. If the tunnel had been continued, it would have intersected the Protectora vein at a depth of about 400 ft. About 500 ft. from the tunnel there is an old five-stamp mill. With the exception of three fairly well preserved boilers, the machinery is useless, although the mill site, with its excavations, could be utilized for the erection of a modern mill.

The Picacho district, situated about 20 miles east of Rosario, is known for its production of gold, which is recovered by amalgamation in arrastres from several prospects worked in a small and desultory manner. It is also known for its placer gold, which is still being produced from Picacho Creek. Copper ores and other minerals are known to exist, but as Rosario, Panuco, and Mazatlan are entirely gold-silver districts, no one pays any attention to other ores than those carrying silver and gold.

Near the summit and on the west slope of the mountain, in ground adjoining the foregoing gold prospects, a copper vein outcrops for a distance of approximately one mile. The strike is north and south. Two east-



Panuco mill and cyanide plant

west veins which intersect the longer north-south vein are also in evidence.

Miners working in a near-by gold prospect were following a rich stringer and encountered copper ore. This in my opinion is part of the large north-south vein in the vicinity. The vein at this point is about 3 ft. in width, 18 in. of which is chalcocite. Three samples were taken from this vein and gave the following:

No. 1—Copper, 39.9 per cent; silver, 19.0 oz.; gold trace.

No. 2—Copper, 14.9 per cent; silver, 20.5 oz.; gold trace.

No. 3—Copper, 38.8 per cent; silver, 49.0 oz.; gold trace.

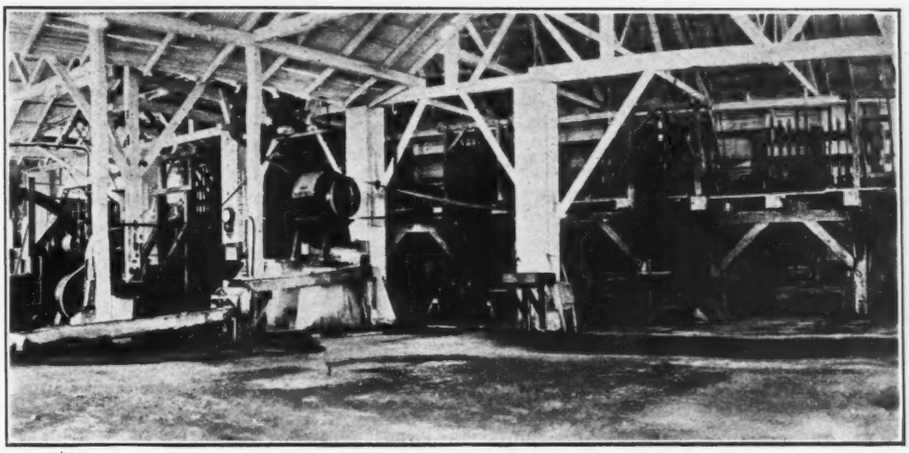
On the east slope of Picacho Mountain, and also near its summit, lead ore outcrops in two places situated about 700 ft. apart. The first outcrop occurs in a small hole dug on the side of the hill and shows about six inches of a somewhat decomposed cerussite (lead carbonate); the second occurs in a shallow pit dug on the hillside. Two feet of cerussite somewhat stained by copper carbonate were observed in the working. Samples of this ore gave the following results:

No. 1—Lead, 68 per cent; silver, 74.3 oz.; gold, 0.14 oz.

No. 2—Lead, 62 per cent; silver, 197.5 oz.; gold, 0.26 oz.

No. 3—Lead, 54 per cent; silver, 114 oz.; gold, 0.34 oz.

About 30 ft. below the workings just described a trench was started and this opened up a solid vein of



Interior of the Tajo mill

Mill and cyanide plant of the Tajo Mines

melaconite (black oxide of copper) about 2 ft. in width, on either side of which were stringers 6 to 8 in. wide of clean galena. The melaconite assayed 60 per cent copper and 15 oz. silver and the galena 75 per cent lead and 2 oz. silver.

The surrounding country is well timbered with hard wood. The Baluarte River runs in a deep gorge at the foot of the mountain. Cheap hydro-electric power could therefore be developed.

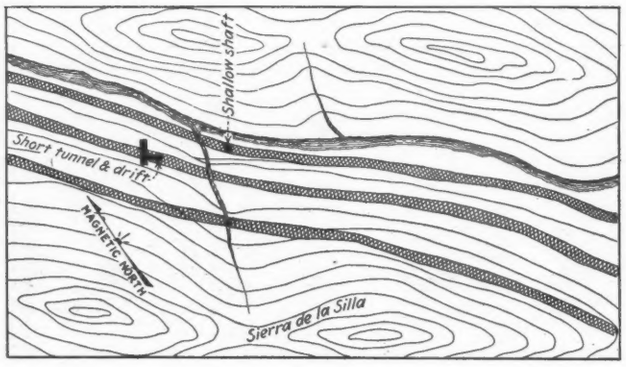
Several interesting gold prospects occur in a strongly mineralized country about 40 miles southeast of Mazatlan and in the vicinity of La Loma de la Silla. The ore is similar to the Oatman (Ariz.) ore; that is, the quartz is in large part a replacement of calcite, and where richest in a dense cryptocrystalline mass of the pale yellow color of beeswax. The ore also contains microscopic adularia. Its metallic constituents are chiefly gold and silver, although manganese and iron oxides are also present. Native gold is often present—more so than at Oatman—in the iron oxides, or in close proximity, in association with the oxides. The gold is disseminated throughout the rock in such minute particles that if a sample of this ore is tested with the horn-spoon, the results would be very misleading, and the ore would not show the values which would be found by assaying it.

Three veins from 4 to 6 ft. wide occur at this place. They are parallel, and extend on the slope, and with the trend of the hill, on which they are situated. (See sketch.) The first and widest is close to a creek, the second about 75 ft. above this creek, and the third is 60 ft. higher up on the slope of the hill. The veins outcrop for over 3,000 ft. They cross a gulch at the end of the hill, and were observed to extend into a second hill on the other side of the gulch.

As might be expected, the workings on these veins are shallow and unsystematic. The ore mined is hand sorted and treated in arrastres, six of which were in operation. The Mexican miners working here were surprised that such poor returns were obtained. Ore assaying from $20 to $30 per ton could not be treated profitably. The extraction from their richer ore was also poor. This was due to the fineness of the gold and to the fact that the ore was not amenable to amalgamation. The treatment should have been cyanidation.

With respect to the accessibility of these prospects, I may say that the Protectora and Duende mines can be approached by wagon road from Mazatlan to within

three miles. The Picacho prospects can be reached only by a poor and rough trail. The gold prospects can be approached by wagon road from Mazatlan to within a few miles. A road to connect the gold prospects to the main road could be built easily and cheaply.



Sketch map showing gold prospect near Mazatlan

In the Mazatlan district mine labor is plentiful, efficient, and cheap. Political and industrial conditions in Mexico are now greatly improved. The places which I have described are worthy of consideration by mining men. The last place mentioned might, in my opinion, be developed into a second Oatman district.

A Metallurgical Phenomenon

How a Crack in the Wall of a Lead Blast Furnace Crucible Developed

By D. W. Jessup

THE action of natural forces in the weathering and erosion of rocks is well known. Water, freezing in crevices, causes an immense pressure that breaks huge rocks. Growing trees, roots, and chemical reactions, as well as other agencies, have resulted in the same effect. This is also exemplified under other conditions as shown by the accompanying photograph of a lead blast-furnace crucible, in which a large crack was caused by the slow oxidization of impregnated matte and bullion.

During the war, the high price of metals warranted the smelting of many low-grade ores that otherwise would have been unprofitable. To meet this excessive demand, one of the large lead smelters erected a blast furnace of such material as was on hand. Instead of building the crucible entirely of brick, as is the custom, only the inner lining was constructed of brick, the remainder being concrete. The whole was held together by large cast-iron binders discarded from a copper blast furnace.

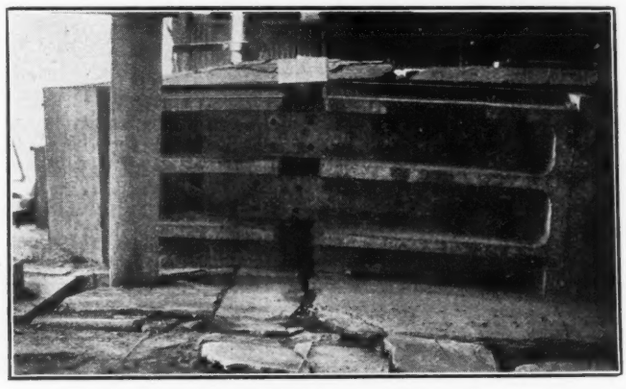
After serving for one campaign, the furnace remained idle for two months, during which time a crack appeared in one of the binders. This crack was at one side and toward the rear end of the crucible. Before blowing in again, the binder was spliced by the aid of two 1-in. steel plates, 10 in. wide, each held in place with eight 1-in. stud bolts.

The furnace finished two more campaigns and was finally shut down owing to ore shortage. Within a few weeks the crack widened and the stud bolts were gradually sheared as with a cutter. When the crack reached a width of about nine inches, it failed to increase in size and remained the same until the crucible was removed. The crack also extended across the floor plates and the foundations for a distance of six feet, as can be seen in the illustration.

About four and one-half years after the furnace was built, the entire crucible was taken out down to the bed plate. Matte and bullion were found to have impregnated the bricks and the concrete in varying amounts. The concrete was of a reddish appearance, owing to the formation of litharge or lead oxide, and the matte occurred in stringers through the entire mass.

Owing to the oxidation of both the lead and the matte, the latter being a sulphide and oxidizing to a sulphate with the absorption of moisture as water of crystallization, the concrete and bricks had expanded with sufficient force to cause this wide break in the binder and the floor. The total breaking load or tension required was computed to be 1,640 tons, which seems almost incredible when the small mass of bricks and concrete is taken into consideration.

The spreading of the binder continued for over one year after the furnace was shut down, indicating that the chemical reactions were continuing throughout that time. With further absorption of matte and lead, the expansion would have been greater and broken a stronger binder. There being more concrete in the rear end of the crucible than in the front, more material was offered for metal absorption, and the break occurred in the rear end. This condition has been noticed by metallurgists, and when a furnace is not in operation, a wood fire will often be built in the crucible to lessen the danger of its cracking. A crucible that has been standing for two months is apt to develop such a weakness, and needs attention before blowing in the furnace.



A 9-in. crack in a crucible wall.

Value of Oxygen-Breathing Apparatus

Regarding the risks attendant on rescue and recovery work, it has been found by the U. S. Bureau of Mines that (1) prior to the use of breathing apparatus, many lives of rescue men were lost, and the work of rescue was delayed by men rushing into the afterdamp; (2) rescue crews have been killed by second explosions resulting from fires, making it hazardous to advance the ventilation, whereas under similar conditions the breathing apparatus has been of great value in reaching and putting out fires in advance of the ventilation; (3) the training of a large number of miners in the use of the apparatus and in organized methods of procedure has brought about an improvement in discipline following mine disasters and fires; and (4) the great majority of deaths to persons lost while wearing breathing apparatus has been due to failure to use it properly.

Recent Patents

Blast Furnace—No. 1,439,957. Dec. 26, 1922. U. A. Garred, Elmhurst, N. Y., assignor to Garred-Cavers Corporation, New York City. A blast furnace of special design adapted to burning powdered coal introduced through the tuyères. A constriction is made just above the tuyères, the space below serving as a combustion zone.

Refractory—No. 1,400,766. Jan. 2, 1923. H. H. Buckman, Jacksonville, Fla., and G. A. Pritchard, New York City, assignors to Buckman & Pritchard, Inc., Jacksonville, Fla. A highly refractory material containing zircon and a refractory carbide.

Placer Mining Machine—No. 1,442,192. Jan. 16, 1923. James Tallon, Long Beach, Calif. A portable machine with riffles for recovering the heavy material from placer deposits.

Hydraulic Separator—No. 1,442,199. Jan. 16, 1923. H. R. Wahl, Chicago, Ill. A tank and appropriate mechanism for separating sand and slime.

Air-Lift Agitator — No. 1,442,264. Jan. 16, 1923. G. T. Geringer, Aroroy, Philippine Islands. An apparatus to act as an air lift and agitator in connection with tanks treating ore pulp.

Flotation Machine — No. 1,442,306. Jan. 16, 1923. David Stonebraker, Park City, Utah. A flotation machine of the cascade type.

Casing Head for Oil Wells—No. 1,442,404. Jan. 16, 1923. Leo Haubert, Beggs, Okla. A new design for a casing head for oil wells.

Refractory Material — No. 1,442,413. Jan. 16, 1923. Zacharias Olsson, New York City, assignor of six-tenths to August Rust-Oppenheim, New York City. A refractory material comprising not less than 95 per cent bauxite and not more than 5 per cent bentonite.

Mechanical Roasters—No. 1,442,595. Jan. 16, 1923. Franz Arend, Jacob Schwalb, and Wilhelm Sonnemann, Frankfort-on-Main, Germany. A method of fastening the scraper arms to the vertical shaft of a multiple-hearth roasting furnace.

Roasting Zinc Sulphide—No. 1,443,707. Jan. 30, 1923. H. W. Gepp, Melbourne, Victoria, assignor to Electrolytic Zinc Co. of Australasia Proprietary Ltd., Melbourne, Australia. Ores containing about 6 to 10 per cent of sulphide sulphur are roasted at a relatively low temperature in the presence of air so that a maximum conversion to metallic sulphate is secured. Patent No. 1,443,708 covers much the same process, successive additions of raw ore being made to the roasting mixture to bring the sulphide sulphur to about 2 per cent.

Flotation—No. 1,444,552. Feb. 6, 1923. C. M. Nokes, Salt Lake City, Utah, assignor to Eureka Metallurgical Co., Salt Lake City. Non-sulphide ore is prepared for flotation by mixing with it sodium sulphide and a solid hydrocarbon.

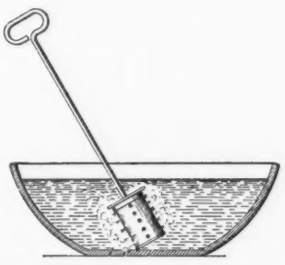
Gold Pan—No. 1,444,752. Feb. 6, 1923. E. O. C. Ord, Berkeley, Calif. A miner's gold pan with a ribbed bottom to aid in washing out the gold.

Electrolytic Apparatus—No. 1,444,787. Feb. 13, 1923. W. E. Greenawalt, Denver, Colo. Method of placing horizontal electrodes in a cell and establishing the necessary electrical connections.

Roasting Furnace—No. 1,444,927. Feb. 13, 1923. A. V. Leggo, Melbourne, Australia. A design for a multiple-hearth ore-roasting furnace.

Flotation Machine — No. 1,445,042. Feb. 13, 1923. J. P. Ruth, Jr., Denver, Colo. Design for a flotation machine of the mechanically agitated type.

Metal Refining—No. 1,443,920. Jan. 30, 1923. A. H. Levy, New York City. Means for holding flux below the level



of a bath of metal, as shown in the accompanying illustration.

Roasting Furnace—No. 1,444,209. Feb. 6, 1923. R. D. Pike, San Francisco, Calif. A new design of multiple-hearth roasting furnace with the rabble arms cooled and covered with a refractory and insulating material.

Zinc Leaching—No. 1,444,484. Feb. 6, 1923. E. P. Stevenson, Cambridge, Mass., assignor to Arthur D. Little, Inc., Cambridge, Mass. Material containing zinc oxide, hydroxide, or carbonate is treated with a concentrated solution of ammonium sulphate at a temperature not less than 100 deg. C. The solution is then cooled to precipitate the basic sulphate of zinc, which is then separated from the solution. Patent No. 1,445,366, issued to the same applicant on Feb. 13, covers the digestion of the basic sulphate as above secured, with a soluble alkali, and calcining the precipitate formed to produce zinc oxide.

Ore Grinder—No. 1,444,485. Feb. 6, 1923. J. O. Thomas, Vancouver, B. C. A new design of apparatus for grinding ore.

Treatment of Carnotite—No. 1,445,660. Feb. 20, 1923. W. F. Bleecker, Boulder, Colo., assignor to the Tungsten Products Co., Boulder, Colo. A process for extracting vanadium and radium from carnotite ores consisting in heating the finely ground ore mixed with hydrochloric acid, an oxidizing agent, and a soluble fluoride.

Filtration—No. 1,446,378. Feb. 20, 1923. W. O. Borcherdt, Austinville, Va., assignor to the New Jersey Zinc Co., New York City. A method of dispersing colloids in ore pulps, and separating them from the remainder of the pulp, which can then be filtered with greater facility.

Technical Papers

Quarrying Problems—"Quarry Problems From the Engineer's Viewpoint" are discussed in a 5-p. paper by Oliver Bowles, published as Serial No. 2,429, *Reports of Investigations*, U. S. Bureau of Mines, Washington, D. C.; obtainable on request.

Mining in India—The Report of the Chief Inspector of Mines in India for the calendar year 1921, p.p. 100, is now obtainable for 3 rupees from Thacker, Spink & Co., Calcutta.

Aluminum Statistics—The Imperial Mineral Resources Bureau has issued a 31-p. booklet containing production and trade statistics of aluminum, bauxite, and cryolite for the principal countries, for the years 1919, 1920 and 1921. Copies may be had for 1s. 1½d. from H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2, England.

Diatomaceous Earth—U. S. Bureau of Mines *Reports of Investigations*, Serial No. 2,431, obtainable on request from the Bureau at Washington, D. C., is a 2-p. paper describing the mining of diatomaceous earth at Lompoc, Calif.

Helium—The U. S. Bureau of Standards, Washington, D. C., has published a second edition of its bibliography of the scientific literature relating to helium, bringing the references up to date. It may be obtained on request to the Bureau for Bulletin No. 81.

Explosives—The "Effect of Cartridge Diameter on the Strength and Sensitiveness of Certain High Explosives" is discussed in U. S. Bureau of Mines *Reports of Investigations*, Serial No. 2,436, pp. 11, obtainable free from the Bureau at Washington, D. C. It is urged that 1¼-in. cartridges are much more satisfactory than ¾-in. and that every effort should be made to use drill holes of such a diameter as will accommodate the larger cartridges.

Liquid Oxygen—Alfred James has a 13-p. article in the *Bulletin* of the Institution of Mining and Metallurgy for February (Cleveland House, 225 City Road, London, E. C. 2, England; price of the separate, 1s.) on "Liquid Oxygen in Mining." He discusses the advantages of liquid-oxygen explosives and describes the practice at Real del Monte and in Europe. The improvement in working conditions owing to absence of noxious gases is noted.

Wyoming Mining—The report of the State Geologist of Wyoming for the two years ending Sept. 30, 1922, pp. 34, is now available from the office of the State Geologist, Cheyenne, Wyo. It is largely concerned with oil and gas and includes a map of the oil and gas fields of the state.

Ceramic Bibliography—The U. S. Bureau of Mines, Washington, D. C., has published a list of the publications on ceramic investigations of the Bureau. Copies may be obtained by applying for *Reports of Investigations*, Serial No. 2,437, pp. 6.

SOCIETIES, ADDRESSES, AND REPORTS

Mine-Fire Control Safety Orders Issued in California

Industrial Accident Commission Makes New Code of Rules to Protect Men at Work

SAFETY ORDERS covering the control of mine fires have just been issued by the California Industrial Accident Commission for the purpose of protecting workmen. The complete text of the commission's announcement follows:

"1. Certain fundamental rules applicable to the majority of mining properties should be adopted for the protection of workmen. In drafting the following Mine Fire Control Safety Orders, it has been borne in mind, however, that mine fire protection depends to a large extent on local conditions and that conditions vary greatly in different mines and in different parts of the same mine. Where the enforcement of any order would work a hardship or fail to provide adequate protection in any individual mine, or where any order is unnecessary because of absence of fire hazard:

"(a) Such individual mine, if it desires exemption, must apply for, and the Industrial Accident Commission may grant, an exemption from or authorize a substitute for any order not reasonably applicable.

"(b) The Industrial Accident Commission may, by special hearing and special safety order, as provided by the Workmen's Compensation, Insurance and Safety Act of 1917, prescribe a special plan for fire prevention and fire control in a particular mine, as a substitute for the requirements made by these orders, where they do not reasonably apply, provided that the measure of safety prescribed by such special safety order shall be substantially equivalent to the measure of safety contemplated by these orders.

"2. The superintendent of each mine shall, with thirty days from the date these orders become effective, formulate and report to the Industrial Accident Commission his plans for compliance with these orders, stating, in addition, when work on such plans will be commenced and when such work will be completed. Such work shall be commenced within thirty days from the date these orders become effective and shall be completed within six months thereafter, unless the time be extended by the Accident Commission.

"3. (a) The superintendent of each mine shall organize his employees for fire prevention, fire control, and the rescue of men underground, and shall formulate and reduce to writing a plan of action to be followed in case of fire in designated zones of the mine. He shall instruct his underground technical staff, foreman, bosses, hoist engineers, skip tenders, shaft topmen, and other employees whose services will be required in emergencies, in the duties assigned to them and shall require such men to attend monthly classes of instruction.

"(b) To insure the familiarity of all employees with the rules and appliances provided for fire emergencies and with the emergency exits, general fire drills shall be held at least once in every three months for each shift. At these drills the men need not be removed from the mine, but shall be assembled in main exits or stations.

"4. (a) Within ninety days after the adoption of these orders each mine shall prepare a diagram showing the position of (1) exits, (2) principal levels, (3) manways, (4) tunnels, (5) shafts, (6) fire doors, (7) water lines available for fire fighting and fire extinguishers, (8) telephones and telephone lines, (9) principal compressed-air lines, (10) direction of air currents and (11) refuge places. Such diagram need not show boundary lines, outlines of orebodies, or other details not essential for the safety of the employees. Copies of said diagrams shall be placed in frames behind glass near the entrance of the mine most frequently used by the men and at such principal working stations as may be designated by the superintendent. A copy shall be sent to the Department of Safety of the Industrial Accident Commission. This diagram shall be brought to date at least once in six months.

"(b) The superintendent shall require weekly inspection of the main shaft and the underground workings for any conditions tending to increase the fire hazard. Second exits and other portions of the mine not regularly frequented shall be inspected for fire hazards and deterioration of ladders or of other appliances necessary to maintain an adequate escapeway, upon regular rounds through such places, and in any event at least once each month. If any condition be found in a second exit making it inadequate for an escapeway, repairs shall be commenced immediately and completed with reasonable diligence. A signed report of each inspection shall be kept in the mine office, whether hazardous conditions be found or not. (Note: See Mine Safety Order 1701 (b) for requirement of special reports to be made to the Accident Commission regarding any unusual hazard noted).

Fire-Fighting Equipment

"5. Each mine in which the main working shaft or adit is timbered and the timber is not protected against fire by fireproofing or by being constantly wet, or in which mine stations are in an inflammable condition, or wherein the workings are considered by the Industrial Accident Commission to constitute a local fire hazard of more than nominal proportions, shall be equipped with the following fire-fighting apparatus, which shall be maintained in good order, for instant use:

"(a) A supply of water for fire fighting so distributed that a stream of water can be had at any mine station at which a fire hazard exists and throughout timbered and non-fireproofed portions of the shaft, with necessary connections for the attachment of hose[1] and an adequate supply of hose so arranged that it can readily be put in a skip, cage, or other conveyance. The hose shall be kept at the mine entrance and on each working level, and at such other places as may be required by the Industrial Accident Commission. All water main outlets, hose couplings and nozzles shall be of standardized size throughout the mine.

"(b) Where the water supply is inadequate or cannot practicably be applied to meet the requirements of subsection (a) above, special fire-fighting equipment and protection according to a plan to be submitted to and approved by the Industrial Accident Commission.

"(Attention is called to the possibility of using water skips or connections so arranged as to direct a stream of water around the entire area of the shaft. Chemical fire extinguishers of approved types would also be applicable under this section).

"(c) All electrical equipment underground, such as motors, transformers, etc., shall be provided with a supply of dry sand, supplemented by one or more small fire extinguishers of a type approved by the Industrial Accident Commission. Where carbon tetrachloride extinguishers are provided, care must be taken that they be not used where the ventilation is deficient.

"(d) In addition to requirements of Mine Safety Order 1725, there shall be provided at all mine openings where inflammable structures exist a system of fire hydrants with sufficient hose or monitors properly placed and connected with the main water supply system.

"(e) All equipment intended solely for fire-fighting purposes shall be tested or carefully inspected at monthly intervals and defective equipment replaced immediately. All hand chemical fire extinguishers of the soda-acid type shall be refilled every six months and the date of last refilling marked on a tag attached to the extinguisher.

"6. (a) Emergency fire doors or bulkheads shall be placed throughout each mine to prevent smoke and gases from any fire cutting off the escape of men working in the mine, according to a plan to be submitted to and approved by the Industrial Accident Commission. Such doors may also be used for the control of normal mine ventilation.

"(b) The bulkheads, door frames and fire doors shall be constructed of gas-tight material.

"(c) The fire doors shall be provided with suitable latches or other mechanical device, so that they may be opened from either side, but cannot be opened by the reversal of the air current.

"7. (a) Mechanically produced and positively controlled air currents shall

[1]Attention is called to the advisability of having connections for hose so placed that a stream can be directed upon any station from above and below the station in the event of a fire at the station.

be provided for each mine more than 1,000 ft. in depth (measured along the line of the shaft), unless it be proved to the satisfaction of the Industrial Accident Commission, as evidenced by its written approval, that mechanically produced air currents would not be feasible, effective or necessary.

"(b) When fans are used, the principal fan or fans shall be installed on the surface, and air ducts so arranged that mine entrances can be used for rescue or other purposes. Such fan or fans shall be so installed that the ventilating current can be quickly reversed in direction. All surface fans, casings and air ducts connecting with the mine openings and also the fan houses and other buildings in close proximity, shall be made of non-combustible material throughout, or, if of combustible material, shall be fireproofed. All underground fans operated by electric motors shall be of non-combustible construction and the immediate vicinity fireproofed if combustible material be present. No surface fan house shall hereafter be erected within 50 ft. of any inflammable structure.

Emergency Equipment

"8. (a) At every mine employing more than twenty-five men underground on any one shift, there shall be provided five sets of approved oxygen breathing apparatus, which shall be maintained in good order in a readily accessible fireproof place on the surface. Every mine employing twenty-five men or less underground on any one shift, but having ten or more employees in all, shall within thirty days from the date these orders become effective, submit to the Industrial Accident Commission a description of its fire hazard with reference to the lives and safety of its men and it plans, if any, for providing oxygen breathing apparatus and men trained in its use and in rescue work. If it should appear to the Industrial Accident Commission that such mine is not or cannot practicably become a member of a co-operative mine rescue station because of isolated location or otherwise, and that oxygen breathing apparatus should reasonably be provided, the Industrial Accident Commission may order the installation of such oxygen breathing and other rescue equipment as may be advisable under the circumstances.

"(b) Any mine that is a member of a co-operative mine rescue station equipped with ten or more sets of oxygen breathing apparatus that can be brought to the mine in good order within one hour after notification, need not provide oxygen breathing apparatus for its individual use. At the co-operative stations, sufficient spare parts shall be kept to assemble at least one additional apparatus in good working order, in addition to the parts and supplies required by Mine Safety Order 1704 (d).

"Each co-operative station shall have a foreman in charge; he shall occupy living quarters adjacent to the co-operative station and shall be available immediately to all members of the station in time of emergency. Telephone communication shall be maintained between the co-operative station, the foreman's residence and each mine served by such station.

"(c) Each mine employing more than twenty-five men underground on any one shift shall have approximately 5 per cent of its underground force on any one shift with a minimum of five men, trained in the use of oxygen breathing apparatus. Such men must renew their training at intervals of at least once in each two months by wearing apparatus in noxious atmospheres for one hour.

"The foregoing requirements covering the maintenance of oxygen breathing apparatus are in addition to paragraphs e, f, and h of Mine Safety Order 1704.

"9. (a) Each mine required to have a second exit shall maintain two telephone lines so arranged as to provide two means of communication between each working level and the surface. Such lines shall be placed in separate shafts or openings. Such telephone lines must be tested weekly and maintained in workable condition.

"(b) Each mine required to have a second exit, except such as are excluded hereafter, shall maintain in it an auxiliary compressed-air line with proper outlets at suitable points for use in emergency at working levels and elsewhere, in addition to the line provided in the main working shaft. Such second compressed-air line shall be at least two inches in diameter (except where a smaller size is approved by the Industrial Accident Commission), and be connected with any underground refuge chambers. This requirement does not apply to mines connected with adjoining mines at or near working levels or to any mine where it is established to the satisfaction of the Industrial Accident Commission, as evidenced by its written approval, that an adequate supply of good air can be supplied to workmen below in the event of a fire, by mechanically controlled ventilation or otherwise.

"10. Where connections have been established between adjoining mines for an emergency exit, two doors shall be provided in the connecting passage, and each mine shall provide a telephone between the doors. Compressed-air lines equipped with valves shall be run from the compressed-air system of each mine to the space between the doors, but need not be interconnected. (For additional requirements see Mine Safety Order 1723).

"11. Each mine required to have a second exit, except as exempted below, shall be provided with one or more places of refuge suitably placed, protected from gas or fire by adequate fire doors, and provided with telephones and compressed-air lines, connected with both the main and auxiliary telephones and air lines. Such places shall contain materials ready for use to make the fire doors air-tight, such as cement, clay or oakum. Such places must be further provided with water sufficient for refuge purposes. Such water must be changed at reasonable intervals. The provisions of this section shall not apply where the second exit is in such condition that it will require one hour or less for employees to come from the bottom level of the mine to the surface through it, or where a connection is made with an adjacent mine, or where sufficient good air can be supplied to workmen below, in the event of fire, by mechanically controlled ventilation or otherwise.

"12. Each mine required by law to maintain a second exit shall protect underground employees against the hazard of all exits becoming impassable through fire or fire gases, by one or more of the following methods:

"(a) By fireproofing the main shaft and shaft stations, provided that where there is no fire hazard sufficient to interrupt the use of the main shaft hoist for rescue purposes, such conditions shall be a sufficient compliance.

"(b) By maintaining a connection between working levels of such mine and an adjoining operating mine.

"(c) By such mechanical control of the air currents as will permit the supplying of good air through any shaft or escapeway by reversal of air currents, if necessary.

"(d) If none of the foregoing methods can be made applicable to a particular mine, such mine may, after a special hearing, be required by the Industrial Accident Commission to install and keep in usable condition a hoist in a second exit.

"(Where the use of a series of raises is contemplated for an emergency exit, the mine management is strongly advised to select the position of the raises so as to have them in line with one another, so that hoisting equipment can be installed if advisable).

"13. A surface fire alarm consisting of a siren or equivalent device shall be installed and used for the purpose of giving a general fire alarm at the surface when fires are reported in the surface plant or underground. As a means of informing underground workers of fire, mines that are equipped with a compressed-air system shall install an approved method of stench warning, and, in addition, shall establish a general danger signal by flashes or distinct interruptions of the electrical lighting current or by telephones.

Fire Prevention

"14. (a) All material near the electrical equipment, such as motors, transformers, etc., shall be non-inflammable or fire-resistant.

"(b) All used mine openings for a distance of 25 ft. from the surface and all used underground stations having a fire hazard shall be constructed of fireproof material or maintained in a non-inflammable condition by the use of water. Steel supports, concrete, gunite or cement plaster are recommended for consideration. It is further recommended that at regular intervals in the main shafts and haulageways, certain sections be made fireproof. Note: See Mine Safety Order 1741 (g). Inflammable Structures Near Mine Opening.

"15. Fires for heating shall not be permitted underground, and open torches, acetylene lamps and candles shall not be left unattended in any mine in the vicinity of wood or other inflammable material. (This shall not be construed to prohibit the use of torches or heating devices necessary for mechanical repairs, provided such devices have continual attendance while lighted.)

"16. The Electrical Safety Orders issed by the Industrial Accident Commission apply to mining operations. All electrical equipment shall be inspected monthly by a competent person designated by the mine superintendent.

"17. The superintendent of each mine shall file with the Industrial Accident Commission such additional reports, plans, diagrams, and maps relative to fire protection and prevention as may be required by the commission. The Industrial Accident Commission will furnish forms for all required reports."

MEN YOU SHOULD KNOW ABOUT

J. W. Mercer is at the Zaruma Mines in Ecuador.

Dr. Kuno B. Heberlein has left for Europe on business.

Charles W. Merrill, of San Francisco, visited New York City last week.

J. H. Lewis expects to return to New York from Chile about the end of this month.

R. F. Heffenreffer, Jr., president of the Utah Apex Mining Co., has returned to Boston after a visit to Utah and California.

F. I. Cairns, superintendent of the Michigan smelter at Houghton, Mich., has returned from a vacation trip in the South.

A. A. Beville, of Hibbing, Minn., a mining engineer for the Cleveland-Cliffs Iron Co., is making a four weeks' trip to Louisville, Ky.

W. H. Schacht, general manager of Copper Range Consolidated mines, has returned to Painesdale, Mich., from a visit to New York.

T. E. Siebenthal, who returned recently from Rio de Janeiro, is now superintendent at the York iron mine, at Nashwauk, Minn.

Orlan L. Dallas, formerly with the National Exploration Co., of New York, is now chief geologist for the Admiral Oil Co., at Fort Worth, Tex.

A. F. Keene, of New York, engineer to the Consolidated Gold Fields of South Africa, was in San Francisco, before going to the Comstock.

M. M. Duncan, vice-president and general manager of the Cleveland-Cliffs Iron Co., of Ishpeming, Mich., is taking a month's vacation at Camden, N. C.

W. W. Shelby has been appointed superintendent of Cia. Minera Nazareno y Catasillas, in the Concepcion del Oro mining district of Zacatecas, Mexico.

James H. Atkin and **W. S. McRae,** of the firm of Atkin & McRae, have moved their offices in Los Angeles to 518 Jewelers Exchange Bldg., 747 South Hill St.

W. C. Mendenhall, K. C. Heald and **A. F. Melcher** conferred in Shreveport, La., on March 22-24 with certain members of the American Association of Petroleum Geologists.

F. L. Ransome addressed the geology classes at Lehigh University on the geology and ore deposits of Arizona and made an informal talk on preparation for work in economic geology.

A. W. Ambrose, the assistant director of the U. S. Bureau of Mines, who recently was made head of the Bureau's leasing branch, is paying a visit to all of the field offices having jurisdiction over leasing matters.

H. K. Linn, who has recently been engaged professionally in Mexico and Arizona, left New York on March 17 for the Belgian Congo where he will be identified with interests engaged in diamond mining.

E. J. Carlyle, smelter manager for the British America Nickel Corporation, at Nickelton, Ontario, has recently resigned and, after an extensive trip through the metallurgical centers of this country and Canada, will open an office in Nickelton.

John A. Dresser, who was elected president of the Canadian Institute of Mining and Metallurgy at the Montreal meeting, had served as vice-president of the Institute and as a member of its Council. Mr. Dresser is an M.A. and B.A. of McGill University. After leaving McGill he took a post graduate geological course at Harvard and subsequently became principal of a college at Richmond, Quebec, affiliated with McGill, incidentally engaging in field work. His activities in this latter respect made him familiar with general geological conditions. He later was attached to the permanent staff of the Dominion Geological Survey and since then has specialized in the asbestos, copper and chrome iron deposits of the eastern townships of Quebec. He was retained by the Lake Superior Corporation to look after the geological and mining affairs of its subsidiary companies.

J. A. Dresser

In recent years he has practiced his profession, with Montreal as his headquarters. The British Columbia Government availed of his services to direct its explorations for oil, and he is consulting geologist with the Natural Resources Department of the Canadian Pacific Railway.

Robert V. V. Anderson has returned from the West Indies where he has been carrying on oil investigations. Mr. Anderson expects to sail soon for London. He is a director of the Whitehall Petroleum Co. of London.

James A. Barr has recently completed a series of examinations in eastern Tennessee, New Mexico, and Parral, Mexico. He left the first part of this week to inspect the mines and washer of the Wayne Iron Corporation at Williamsville, Mo.

Dr. Waldemar Lindgren, professor of economic geology at the Massachusetts Institute of Technology, has been appointed consulting engineer for the Eureka Smelting and Mining Co. **A. P. Mayberry,** of Salt Lake City, will be in charge of mining operations.

Dr. F. W. McNair, president of the Michigan College of Mines at Houghton, will attend a meeting of the Board of Visitors of the Bureau of Standards at Washington March 19 and 20. Dr. McNair was recently appointed to this board by Herbert Hoover, by whom the meeting was called.

F. J. Bailey, assistant to the Director of the U. S. Bureau of Mines, and **D. J. Parker,** chief engineer of the Bureau's mine safety service, are visiting the various safety cars and stations. Their itinerary includes Salt Lake City, Globe, Bakersfield, Los Angeles, Denver, Caspar, Kellogg, Wallace, Billings, and Butte. At the close of the trip, they will determine whether the next International First Aid and Mine Rescue Meet will be at Salt Lake City or Des Moines.

R. V. Norris, consulting engineer at Wilkes-Barre, Pa., has made his son, **R. V. Norris, Jr.,** a junior partner, the firm to be known as R. V. Norris & Son. R. V. Norris, Jr., is a graduate of Yale, Ph.B., and Columbia School of Mines, E.M. Since graduating he has been assistant colliery superintendent and later mining engineer for the Lehigh Coal & Navigation Co., lieutenant of engineers in the A.E.F. in France, and junior and senior accountant in Los Angeles.

SOCIETY MEETINGS ANNOUNCED

The Northwest Mining Association will hold its annual convention May 22 to 26 jointly with the Sportsmen's Fair. It plans to have a large mineral display. Mining machinery in operation will also be a feature.

The twenty-sixth annual meeting of the **American Society for Testing Materials** will be held at the Chalfonte-Haddon Hall, Atlantic City, N. J., during the week of June 25. The discussion of 1922 on "The Fatigue of Metals" will be continued.

OBITUARY

Charles M. MacNeill, president of the Utah Copper Co. and the Chino Copper Co., vice-president of the Replogle Steel Co., and a director of a number of other corporations, died in New York on March 17. Mr. MacNeill was fifty-two years old. He was born at Oak Park, Ill., and went into the mining business after graduating from high school. His first position was that of cashier with a Colorado smelting firm and at thirty-three years of age he was made president of the Utah Mining Co.

THE MINING NEWS

The Mining News of ENGINEERING AND MINING JOURNAL-PRESS is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Leading Events

WAGE INCREASES starting in copper mining districts of Michigan and Montana spread to Idaho, Utah, Arizona, and New Mexico. Rates raised 30 to 50c., the latter applying to underground men, who are most difficult to obtain.

Vanadium ores are opened in Garfield County, Colo.

Trade unions are denied the right to sue in a Canadian Court.

The better prices for copper have benefited the nickel industry of Ontario.

A rich new orebody has been opened in the United Verde Extension mine in Arizona.

Michigan iron mines are adopting caterpillar-type steam shovels as a measure for reducing the number of men needed.

Miners are leaving the Ontario gold mining districts because of shutdowns resulting from the shortage of hydro-electric power.

The Magma Copper Co. operating at Superior, Ariz., will resume production in April.

Idaho, Utah, Arizona and New Mexico Mine Operators Raise Wages

Effective March 16—About 25,000 Men Involved—New Scale Approaches War-time Maximum

THE large mining companies in Utah, Arizona, and New Mexico have followed those in Michigan and Montana in increasing wages of miners and mill men. In Utah effective March 16 there was a general increase of 7½ to 15 per cent, with a maximum of 50c. per day. Miners will receive up to $5.25 a shift, and muckers to $4.75, which makes a wage scale far higher than that obtaining in 1914, and approximates the war-time scale very closely. Notices of the raise have been posted by almost all of the larger companies. At Bingham, by the Utah Copper, Utah Consolidated, United States, Montana-Bingham, and Utah-Apex companies; at Park City, by the Park-Utah, Park City Mining & Smelting, Silver King Coalition, Keystone, Ontario, and New Quincy companies; at Eureka, by the Chief Consolidated, and its various subsidiaries, the Tintic Standard, Knight and Mammoth companies. About 5,000 men are affected.

In Arizona the copper mining companies have taken the lead in increasing wages. The new scale will give miners $5.45 per day and muckers $4.84; other classes of labor will be increased 10 per cent. It is estimated that 16,000 mine employees in Arizona will be affected, and since other industries in the state have usually found it necessary to make some advances when the mining companies raised wages, an even greater number will be affected.

The same increase will be effective at the 85 mine of the Calumet & Arizona Mining Co. and at the Bonney mine at Lordsburg, New Mexico. The Chino Copper Co., whose mines are at Santa Rita, has made a similar increase.

A 50c. increase for miners throughout the Coeur d'Alene district in Idaho is said to be based on the bonus prevailing in that region, which, with lead at $8, is $1.75 a day. The new rate, effective March 16, will give miners $5.50 a day and muckers $5.00. The number of employees in the Coeur d'Alene region is 5,000 and the increase in payroll $75,000 monthly. According to shippers, the increase in the price of lead will thus be reflected in pay of the miners before many shippers begin to realize on a higher price, due to the interval between the time the product is mined and marketed.

No announcements have been made by other mining companies throughout Oregon, Washington and the districts in the southern part of British Columbia that they will meet the advance initiated in the Coeur d'Alene.

About 475 smelter men employed at the Helena (Montana) smelter of the A. S. & R. Co. were accorded an increase of 50c. per shift effective March 10.

All of these raises are made voluntarily and are the direct consequence of the difficulty in obtaining an adequate supply of workers at the prevailing wages. The similar action taken by the copper mining companies in Michigan and at Butte, Montana, was announced about ten days ago.

Trade Union Denied Standing in Court in Winnipeg, Canada

Non-Suited in Action for Accounting of Former Official—Case Will Go to Great Britain

An important decision in connection with trade unions, recently handed down by Justice Galt in the Court of King's Bench in Winnipeg, Canada, arose out of an action started by the general chairman and secretary-treasurer of the Canadian Division of the Brotherhood of Locomotive Engineers against Samuel Starr, former secretary, to compel him to give an account of funds in his possession when he was relieved from office in May, 1921, at the triennial convention in Cleveland. Starr refused to give up his office, claiming that he had never been notified that his services were dispensed with.

Counsel for the defence attacked the legality of the organization, claiming it was operating in restraint of trade. In his judgment, the judge said that the case had no parallel in Canadian legal circles, and he had to refer to English authorities. He expressed the opinion that under the law the Brotherhood is an illegal organization operating in restraint of trade, and, as such, cannot come to a court of law to adjust differences between itself and the members of the organization, and he accordingly granted a non-suit motion.

The judgment is said to be the only one of its kind ever delivered on the American continent, and is considered in legal circles to be of far-reaching importance in that it affects all trade-union organizations. It is believed that the case will go to the Privy Council in England for final adjudication before the union will be satisfied.

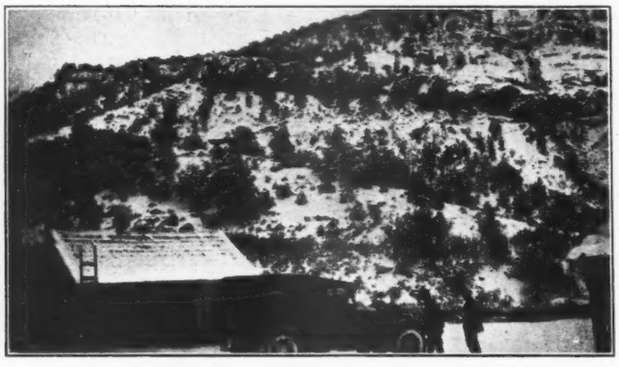
Vanadium Ore Being Opened in Garfield County, Colo.

Developments Indicate "Commercial" Deposit—Property Acquired by New Company, the Vanadium Corporation of Colorado

By George Kunkle

A DEPOSIT that promises to be a new commercial source of vanadium is being opened in the northwestern part of Garfield County, Colo., by the Vanadium Corporation of Colorado, recently organized. H. K. Thurber, for many years associated with the various carnotite and radium-producing companies, is in charge of operations, with Charles Curran, as local manager.

The company has a favorably situated mill site, and plenty of mine timber within easy reach. The haul to Rifle, the nearest railroad point, is only 11 miles and is all down grade. The altitude of the property is about 6,000 ft., insuring mild climatic conditions the year round. The mine openings are only 200 ft. above the level of the public road, which has been extended to the workings.



Outcrop of ledge in which vanadium ore is found

Rifle Creek supplies hydro-electric power to the town of Rifle and its contiguous territory. A high-voltage power-transmission line crosses the property within a few hundred feet of the workings. An irrigation ditch, 20 ft. wide, carrying clear mountain water, cuts through the ore outcrop at one point, and there is an operating coal mine, producing good coal, within two miles of the property.

It has long been known that there existed remnants of carnotite-bearing rocks as far north as Meeker and the White River district in Rio Blanco County, but developments at these points did not inspire confidence. The lenses were tilted and badly broken, and considerable of the ore contained objectionable quantities of copper. This, coupled with the fact that they were as completely isolated as the Paradox Valley and its contiguous deposits, prevented development.

The regional geology of this part of Colorado is Mesa Verde. The distribution of the carnotite-bearing rocks comprise a relatively narrow strip of territory that extends for about 30 miles south of Meeker, parallel with the Great Hogback, at which point it turns southeast and continues for 28 miles, as far east as Glenwood Springs. This new deposit in Garfield County is on the western edge of this strip of territory at the point where it turns southeast, and is near the head waters of Rifle Creek. It occurs in a massive incline of 800 ft. of vertically exposed McElmo, La Plata, and Dolores rocks, which dip at an angle of about 15 deg. to the south, and from 1 to 3 deg. to the east. The ore does not occur in the McElmo, but at the boundary of the bedding planes between the La Plata and the Dolores. The lense of ore follows the same variations in dip as the overlying strata, which is structurally the remnant of an anticlinal fold. The deposit varies from 2 to 7 ft. in thickness, and can be traced from north to south a distance of 1,500 ft., where it dips under the detritus accumulated in the bottom of the canyon.

Several drifts have been driven on the vein at various points. One tunnel has been driven 50 ft. in a body of vanadium ore 7 ft. thick, which contains, from an average of twenty-five samples, 4 per cent of vanadic acid. Two other tunnels have been driven into 3 and 5 ft. of ore at different points with equally high average values.

The ore mined is not roscoelite, but is similar, if not identical, to the vanadiferous sandstone associated with carnotite. This is confirmed by analyses, as the ore contains 0.1 to 0.25 per cent U_3O_8; some small pockets as much as 2 per cent U_3O_8. The ore is of the familiar dark and banded variety, but appears finer grained and slightly heavier than that usually encountered. In some samples there seem to be a slight substitution of magnesium for lime, but otherwise the ore can not be distinguished from the ores of the better-known deposits in other parts of Colorado.

Operations with a small force of men over a period of three months have resulted in blocking out approximately 3,000 tons of ore that will average 4 per cent vanadic acid.

From present indications, production over the next twelve months should yield 10,000 tons of ore containing not less than 400 tons of vanadic acid (V_2O_5). This deposit can be worked cheaply.

Labor Situation in Michigan Shows No Sign of Improvement

4,000 Men Could Be Used—Wage Increase Expected to Hold Present Force

Metal production in the Michigan copper district is unlikely to increase to any great extent during the remainder of the year according to executives at the mines. The labor situation shows no sign of improvement, and it is doubtful whether the recent increase of 20 per cent in wages will solve the problem. It will, however, have the effect of inducing present employees to remain.

Calumet & Hecla is employing approximately 3,500 men, compared with 9,560 in 1918, or about 30 per cent of the 1918 total. This affords some idea of the extent of the labor shortage in the Michigan copper district, other mines being affected in proportion. Economies introduced in the last four years have reduced normal man-power requirements so that Calumet & Hecla's high mark in the future probably will not be more than 7,500. This means, however, that if there is to be a return to "normal" production, at least 4,000 more men must be employed than are now at work.

Some of the Michigan copper companies are advertising for men in newspapers of the Northwest, calling attention to the miner's wage of $4.50 per eight-hour shift and bonus; modern houses for married men at a rental of $5 to $7 per month; steady work; and free fare to the district if the employee works ninety shifts.

Mining Stimulated in Tasmania

By Cable from Reuters to "Engineering and Mining Journal-Press"

Melbourne, March 17—Further activity is expected soon in the Zeehan district of Tasmania in consequence of the Mount Lyell company's intention to increase the production of pyritic ore and the reported formation of a new company to resume operations on the copper and nickel lodes at North Dundas, after a cessation of eight years.

Gold Output in Transvaal

By Cable from Reuters to "Engineering and Mining Journal-Press"

London, March 17—The gold output in the Transvaal during February totaled 704,970 oz.

Ore-Dressing Engineer Will Study Mechanics of Classification

Possibilities of Concentration by Combination of Hydraulic Classification and Screening

In the study of ore classification problems, being conducted at the Moscow, Idaho, field office of the Bureau of Mines by A. W. Fahrenwald, ore dressing engineer, experiments will be conducted, using a small single-spigot glass-tube classifier 2¼ in. in diameter capable of being readily adjusted to lengths between 8 and 13 in. This classifier is constructed so as to permit the use of constriction plates of various designs. The experiments will be made with the object in view of determining approximately the factors necessary to know in order to design a multiple spigot classifier to operate with automatic discharge. The design contemplated, which is a modified application of the Elder hydro-balance principle, will permit regulation of the density of the "teter" bed in any chamber and discharge of the sands at that density. A series of four runs, using the single spigot classifier, has been completed, in which classified sands were discharged at four different densities.

The theory of classification seems to be well worked out, but mill men seem not to understand just where and how classification is done. It, therefore, appears that improvement along this line will come through a development of the mechanics of classifiers. Classification under maximum hindered settling conditions in combination with screening as a method of concentration, would appear to offer considerable possibilities on certain types of ores, particularly on the coarser sizes; the ore from the Bunker Hill & Sullivan mine at Kellogg, Idaho, is ideal for such a study.

Electric Furnace Inefficient in Treating Norwegian Iron Ore

The great hopes which were entertained in Norway in regard to the electric treatment of iron ores started some years ago have not been realized. It is stated that this is chiefly due to the fact that the quality of the Norwegian iron ores is quite different from that of the Swedish ores, where very good results have been obtained in the electric furnace. It should be added that for the reduction in Norway coke is used instead of charcoal. During the years 1910 to 1913 some electric plants were erected in the neighborhood of Tinfos and Ulefos, in which the so-called "Bie-Lorentzen-ovens" with a capacity of about 15,000 to 16,000 tons of iron and a consumption of from 9,000 to 10,000 hp. were installed. But in spite of satisfactory results the conclusion was reached that this type of furnace could not be adopted for the large iron works which it would be necessary to build if an electric treatment of the great iron ore riches of Norway should be considered.

Steam Shovels, Caterpillar Type, Cut Iron-Mine Payrolls

A shortage of miners continues to handicap ore output at nearly all the iron mines of the Lake Superior fields. As a consequence, there are many sales of steam shovels equipped with caterpillar traction that does away with the need of track crews. These shovels are being used for loading cars direct from the ore deposit in the open-pit mines, and for loading from stockpiles into cars. They are very flexible and highly efficient according to the operators who have tried them.

Nickel Industry in Ontario Helped by Better Copper Price

International Expects to Start New Reverberatory in April—British-America Will Resume

The Ontario nickel industry is slowly getting back on its feet despite low prices for the chief product. The fact that copper has advanced several cents per pound will be of marked benefit as this is an important byproduct. The International Nickel Co. at Copper Cliff now has five blast furnaces operating and will start the remodelled reverberatory early in April. This has been rebuilt on the lines of those in use in the West, with a perfectly straight roof from end to end and with means for skimming the slag at the end of the furnace instead of the side as heretofore. The Dwight-Lloyd sintering plant, construction of which was interfered with by the shutdown last year, is expected to be put in operation this spring. This will sinter the mine fines and possibly the flue dust, making them better adapted to the blast-furnace charge. Excellent work is being done in the converter department where two 10 by 37-ft. Peirce-Smith converters produced 2,800 tons of 80 per cent matte in February. Costs are reported very low, and the use of the Garr gun for the introduction of flux has at last been perfected. Donald McAskill is now smelter superintendent; J. W. Rawlins, metallurgist; H. Waern, chief chemist; and L. R. Sheridan, chief engineer.

The British America Nickel Corporation intends resuming operations at the smelter at once, and the Mond Nickel Co. at Coniston, continues smelting at somewhat less than capacity.

Magma Copper Co. Will Resume Output in April

The Magma Copper Co. is to resume mining at Superior early in April, according to a statement made by W. C. Browning general manager. All work in the mine has been confined to development pending the completion of the new standard guage railroad and other construction work at the mine. It is expected that several units of the mill are to be ready by that time. The resumption of production will necessitate the employment of at least 200 additional men, it is estimated.

Washington Mines Ship to Trail Smelter in Canada

Republic District Supplies Dry Silver Ore—British Columbia Sends Lead and Zinc Ore

The ore receipts at the Trail smelter of the Consolidated M. & S. Co. for the first two months of the year totaled 74,542 tons, of which the Consolidated company's mines contributed 65,806 tons. An interesting feature of the receipts has been the heavy shipments received from the mines at Republic, Ferry County, Wash. The Knob Hill, Lone Pine, Quilp, and Surprise mines, at Republic, shipped 4,953 tons of "dry" silver ore, and the Black Rock mine, at Northport, shipped 554 tons of zinc ore. The principal British Columbia shipper, apart from the Consolidated company, was the Silversmith, which shipped 903 tons of silver-lead concentrate and 498 tons of zinc concentrate. The latter, which until the zinc schedule was introduced at Trail was practically a waste product, is bringing the company $45 per ton. It averages 50 per cent zinc and 35 ounces of silver per ton. The only other heavy shipper in the Slocan was the Alamo mill, which sent in 256 tons of concentrate. The Paradise mine, at Invemere, East Kootenay, shipped 557 tons and has fully 1,000 tons ready for shipment. Transportation is slow, though eight teams are continuously employed. The ore is a carbonate, averaging about $50 per ton in silver and lead. The Steel group, on No. 3 Creek, East Kootenay, shipped 136 tons that gave a return of about $70 per ton in silver and lead.

Granby Will Send Blister Copper to Tacoma Smelter

The Granby Consolidated Copper Co. announces a change in policy as to its shipments of blister copper from Anyox, B. C. Hitherto this has gone to Laurel Hill, Long Island. In future it will be sent direct to the A. S. & R. smelter at Tacoma, Wash. for refining. The Anyox smelter has been a heavy shipper through the port of Vancouver, an average of 1,300 tons a month, valued at $450,000, going through that center. Blister has been sent to Vancouver in coasting ships and transferred there to ocean craft bound to New York via the Panama Canal. This has involved payment of port, wharfage, and handling charges at Vancouver, together with insurance and freight to the Atlantic seaboard. Hereafter the ships "Grifco," "Amur," "Anyox," "Marmion," and the fleet of barges will carry the concentrates direct to Tacoma.

Exploitation of Gold Deposits in Spain

By Cable from Reuters to "Engineering and Mining Journal-Press"

Madrid, March 12—A message from Almeria states that representatives of a British company will examine the Rodalquilar gold-bearing zone and proceed to exploit the field.

News from Washington

By PAUL WOOTON
Special Correspondent

War Minerals Commission Awards $17,679 to A. C. Wilcox

Claim Disallowed by Former Commission—"Depletion" Charge Reimbursed —Other Recommendations

By establishing stimulation as of Sept. 24, 1917, A. C. Wilcox, of Morristown, N. J., demonstrated to the satisfaction of the War Minerals Relief Commissioner that his claim comes within the amended act, and an award of $17,679.29 has been recommended in his favor. His claim was disallowed by the former commission. His operations were begun in August, 1917, and continued until October, 1918. Ore to the amount of $12,784.37 was sold. From his expenditures, which totaled $35,965.08, the ore sales were deducted as were $1,616.78 for salvage; $4,271.46 for lease rental; $182.51 for New York office expense, and $709.10 for personal expense. Payments for lease never have been allowable. Commissioner Robinson holds, however, that the claimant is entitled to depletion of his orebody, which at 10 per cent of ore sales amounts to $1,278.43. The deduction for personal expenses was made because a part of it was expended after operations had ceased and because certain items could not properly be charged against the property.

Subject to the approval of the Secretary of the Interior, Commissioner Robinson has recommended other awards as follows: Craig, Creighton, and Graham, Phoenix, Ariz., $2,961.71; N. B. Ringeling, Philipsburgh, Mont., $2,623.35; Charles J. Varozza, Latrobe, Calif., $75; Arthur Gaywood, Boulder, Colo., $476; Turner and Butler, Berkeley, Calif., $378.26; John D. Moran, Seattle, $2,450.65; Trask, Coffer, and Stone, Paxton, Calif., $1,302.70. Disallowances were recommended in the following cases: National Manganese Co., Oklahoma City, no additional award justified; Wanakah Syndicate, Syracuse, N. Y., stimulation not established; Liberty Manganese Co., Independence, County, Ark., commercial importance not established.

Minerals Separation "Unfair Competition" Suit Resumed

The Federal Trade Commission on March 19 heard arguments on its complaint in connection with the Minerals Separation, Ltd., controlled by German and English interests. This proceeding involves the charge of unfair competition through licenses under patents for the flotation process for the separation of valuable minerals from their ores. The American Mining Congress is a party to the proceeding in support of the complaint on behalf of the mining interests in the United States.

Drill Steel Studies Continued by Government Bureaus

Reclamation of Used Drills Will Be Investigated—Nature of Forces Important

Work is to be continued by the Bureau of Mines and Bureau of Standards on the study of drill steel. Particular attention will be directed to a study of the steels that give the greatest service before failure by breakage. This will include a report on microstructure, composition, methods of manufacture, and heat treatment.

An effort is to be made in the study of service qualities to develop better methods of recording service. Microanalysis and magnetic analysis will be resorted to in the study of the mechanics of drill-steel failure. The nature of stresses is to be studied carefully, with particular attention to fatigue of metal.

Continued study is to be made of the nature of the forces involved, which are: Impact; vibratory compressional waves; and combined bending, vibratory, shearing, and torsional forces.

Special studies are to be made as to the importance of heat treatment and use of steels intended for the drilling of oil and gas wells.

One of the important phases of this study deals with the reclamation of depreciated drills. This includes a study of electric and forge welding and the use of electric and oil-fired furnaces.

The work is being done by the Bureau of Mines and the Bureau of Standards in co-operation with an advisory board of which B. F. Tillson is chairman. Designs are now being prepared for a furnace of sufficient capacity which can be operated with a reducing atmosphere and in which drill steels can be heated under pyrometric control. The Bureau of Standards is working on the determination of the proper carbon content of plain carbon drill steel. The Bureau of Mines is attempting to ascertain the proper hardness of drill shanks; how the sharp structural change at the bit and shank ends can be eliminated; the best condition of the steel in the shaft portion for the reduction of breakage, and whether or not the drawing of the bit end is desirable. The Missouri School of Mines is co-operating in that study.

Pittman Act Silver

Purchases of silver by the Bureau of the Mint during the week ended March 17 amounted to 438,000 oz. This brings the total purchases under the Pittman Act to 164,738,674 oz. and leave approximately 43,000,000 to be purchased.

News by Mining Districts

By Special Correspondents in the Field

London Letter

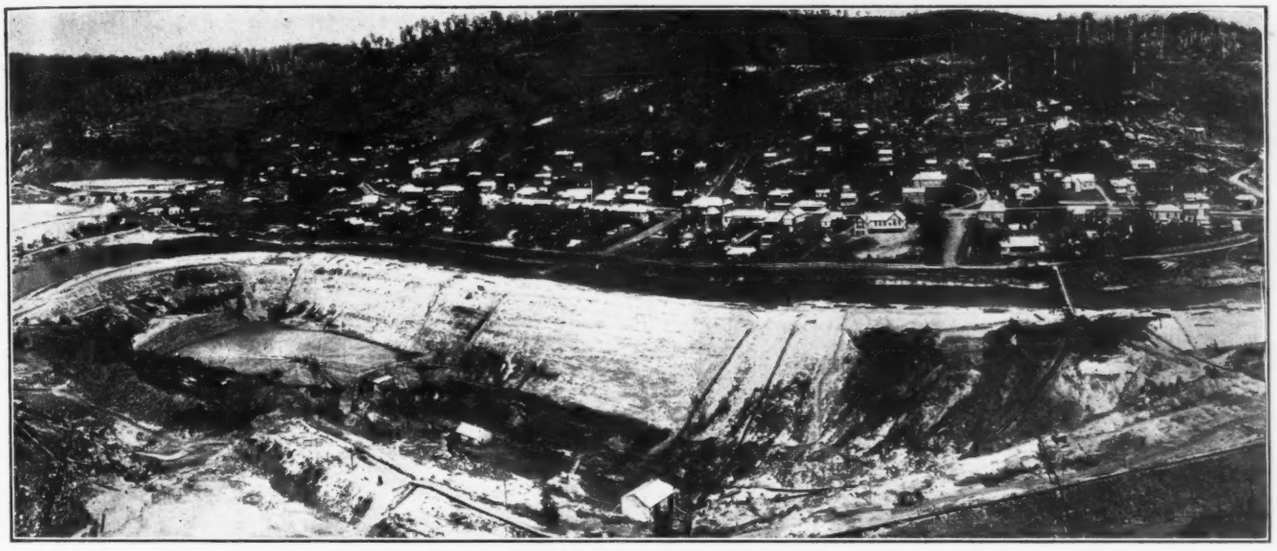
Reorganization Schemes Flourish in London Mining Circles—Capitalization Increased

BY W. A. DOMAN

London, March 9—With the recovery in the prices of base metals, various mining companies are embracing the opportunity of increasing their capitalization or entering into working arrangements. In the latter category come the Esperanza Copper & Sulphur Co. and the Seville Sulphur and Copper Co., both in Spain. The former has a present capital of £350,000 in £1 shares, and the latter £120,000 in £10 shares. The Esperanza company desires to extend its operations and to improve its prospects, and after investigation of the position of the Seville company, has put forward a proposal to acquire a majority, if not the whole, of the shares. With this object each share of the capital of £350,000 is to be subdivided into seven shares of 2½s. each, making 2,450,000 of which 1,400,000 shares are to be surrendered by shareholders. Afterwards the 2,450,000 shares will be consolidated into 350,000 £1 shares again. The 1,400,000 shares are to be regarded as forfeited and available for reissue, and shares to the value of £100,000 are to be allotted to the shareholders of the Seville company. This means that there will be £250,000 in £1 shares of the reorganized capital issued leaving 100,000 £1 shares available for the purpose of the company. The Seville company was established in 1877 to work the Aznalcollar mine, and is one of the oldest concerns in the pyrites trade. From 1877 to 1919 dividends have been paid regularly and amount to about £600,000. Little work is being done owing to the depressed state of the pyrites trade, but the ore reserves are estimated to be sufficient to provide a large output for the next fifty years. The Esperanza company was formed in 1906, and has paid intermittent dividends.

The Bwana M'Kubwa Copper Mining Co. (Rhodesia), of which I have previously written, announces an increase of capital to £900,000, by the creation of 2,000,000 new shares of 5s. each. Of these new shares 1,900,000 are to rank with the existing shares and to be called Ordinary, the remaining 100,000 to be called A shares, each share carrying ten votes. Over 7,000,000 tons of ore have been proved, estimated to contain 3.6 per cent of copper. The Perkins Process of the Metals Production Ltd. is being installed to treat at first ten tons a day, the complete plant to have a capacity of 1,000 tons a day. Minerals Separation will subscribe the capital.

Another copper company that proposes to increase its capital is the South American Copper Co., which will create 250,000 shares of 2s. each, raising the nominal capital to £100,000. As an indication of the price of the shares it may be mentioned that a group of mining finance houses—presumably the Consolidated Gold Fields, the National Mining Corporation and the Omnium Assets Trust Syndicate—have agreed to subscribe to an issue of £100,000 6 per cent notes at par, and of the 250,000 shares to be created, 100,000 are to be reserved for the conversion of the notes at the rate of one share for each £1 note. Of the remaining 150,000 shares, 50,000 are to be under option to the noteholders at 20s. per share up to June 30, 1925, leaving 100,000 in reserve. Two smelters are running and a third is to be erected first as a standby and later to come into full production.



Operations of the Briseis Tin & General Mines, Ltd., at Derby, Tasmania. The diverted river is shown in its new bed. The town is in the background.

Montreal Letter

Hollinger Control Not for Sale—Labrador the "Find of Century," Says Taylor

Montreal, March 16—A story has been doing duty in share markets—which need stimulating—that Solomon Barnato Joel and associates of London, were about to close a deal for control of Hollinger Consolidated Mines of Porcupine. The price was circumstantially stated to be $30,000,000. Control at the current market price represents approximately $33,750,000. The rumor has been denied by Hollinger directors. The properties have a market valuation of about $67,600,000. There is a cash surplus of about $7,000,000. President Timmins is on a holiday en route to Rome, and it seems certain that no negotiations of the sort have been entered into. Being the chief factor in the diamond industry, and an influential element in the Rand gold industry, Mr. Joel could command whatever capital might be needed to consummate a transaction of first magnitude. New York has been willing to report something of the sort attributed to Mr. Joel; but, despite the accepted rule that every mine has its price, Hollinger control is something I believe that the dominant interests will not part with.

John Taylor & Co., of London, are said to have entertained the Scottish-Ontario properties in Northern Tisdale, Porcupine district. These originally were staked in the earliest days of Porcupine by Bannermann Brothers. MacArthur-Forrest people took them over. The section never has appealed to those who are familiar with it, but London fancies it.

Managing Director Taylor of the American-Newfoundland Mining Co., who has spent considerable time of late in New York, makes it known that his company has taken over "twenty-eight miles of areas on the west coast of England's 'Ancient Colony,'" where "assays give a gold return running as high as $18." That is all the information that is forthcoming. To help things along, Mr. Taylor says the Labrador placer find is the "one of the century." That is why sections of eastern Canada are being canvassed by those with Labrador shares for sale.

New York interests in Continental Mines are pursuing a joint exploration and development policy. Instead of picking up the O'Brien-Continental contact at 800 ft., the large shaft now nearing 900 ft. is to be carried down to 950 ft. Owing to the structural conditions noted by the company's engineers and provincial geologists, the greater depth at which it is expected to reach the contact is favorably construed. At Kirkland Lake, the Continental shaft is at about 100 ft. vertical. The shaft passed through the richer section. The intention now is to start exploration at 150 or 200 ft. A hydro-electric power plant is to be installed forthwith.

ONTARIO

Power Shortage Causes Miners to Leave Porcupine

The Northern Canada Power Co. of Porcupine has put another power cut into effect, making the third within a month. The mines are now receiving considerably less than half of their normal requirements, but relief is expected as soon as the break-up comes, which should be within thirty days. Aside from the cutting down of production and the consequent increased cost per ton, the most serious aspect is the effect it is having on the labor supply. A number of men have been thrown out of work, and these are leaving the district. It was anticipated that a labor shortage would probably be felt some time during the coming summer or fall, and if any considerable number of men leave the camp now, this condition will be aggravated.

Increased Development Activity at Porcupine

New work is being started in the Porcupine district. Coniagas is installing a compressor and steel head frame on the new Ray property, and proposes to do a considerable amount of underground development. The La Rose has taken on the Moyer-Bremner properties, and has made a contract for 5,000 ft. of diamond drilling, which is to be started immediately. The Scottish Ontario Mining property has been purchased by the Canyon Mines Ltd., and the Whelpdale has been taken over by the Crystal Copper Co. of Butte, Mont. Work on these properties will be started soon. British capital is interested in the Scottish Ontario and also in the work being undertaken in the Rochester.

Argonaut Increases Capitalization

A special meeting of the shareholders of the Argonaut Gold Mines, Ltd., has been called for the purpose of approving and ratifying a by-law passed by

the board of directors to increase the capital from $3,000,000 to $4,000,000. The increased issue is for three purposes: to amalgamate with the Mine d'Or Huronia, which is under lease to the Argonaut; to purchase fifteen additional claims adjoining the company's property, on which the company now holds options. Possession must be obtained before the mill starts producing on April 15. It is also necessary to reimburse a loan made by some of the shareholders to permit the company to begin production entirely free from debt. Shares of the increased issue will not be sold on the open market, but will be used only for the purposes named.

Keeley Development Reveals Rich Ore

Output of the Keeley mine, in South Lorraine, continues to increase, and during January and February was exceeded in Canada only by the Nipissing mine. The January production amounted to 115,000 oz., and the February production was 153,000 oz. On the 7th level vein 26, 44 ft. of drifting was done in February, which showed an average of 720 oz. across a width of 20 ft. The total developed length of this vein is 74 ft., with an average of 2,600 oz. across 15 in. Other developments continue favorable.

QUEBEC

Asbestos Output Will Be Doubled

The Asbestos Corporation of the Thetford district, Quebec, plans to enlarge its operations. Plans are being considered for the erection of an additional mill of 1,200-ton daily capacity. Renewal of building construction and commercial activities in the United States and Canada has improved the market for asbestos, and the demand for the company's products is greater than it has been for the last two years. Shipments from the property are considerably larger, but prices have declined. With an additional unit of 1,200 tons in operation, the present output will be about doubled.

BRITISH COLUMBIA

Sale of Florence Mine Negotiated

The Florence Silver Mining Co., operating a lead-silver mine at Ainsworth, B. C., has been sold for $1,250,000. The purchaser is a syndicate of Detroit bankers and manufacturers, among whom is D. L. Robinson, according to F. R. Wolfle, president. The purchasers must pay an additional $450,000, for further development of the mine, equipment of the mill and retirement of corporate obligations.

A payment of $150,000 of the sum to be spent for development has already been made and the balance, $300,000, will be paid as soon as the deal has been ratified by the stockholders at a meeting to be held on April 4. The $1,250,000 purchase price is to be paid out of the production.

The syndicate will either take over the old company and increase the capital stock to 1,750,000 preferred and 2,000,000 common or organize a new company. Management will remain with the present board until all of the preferred stock is retired.

Granite Mine Bonded

The Granite Poorman mine near Nelson has been bonded by the Jerome Brothers and associates for $50,000. Extensive devolepment work is planned which will begin at once.

MEXICO

Ball Mills Replace Stamps

The Compania Minera de Palmarito, in the Palmarito district of the State of Sinaloa, is installing a new power plant and reconstructing the mill of 100-ton capacity. Ball mills will be used instead of the stamps formerly in use there. This company has a large tonnage of 20-oz. silver ore ready for milling.

Potrero Company Gets Two Properties

The Potrero Mining Co., operating in the Mocorito district, has recently acquired the Noche Bueno mine, formerly belonging to Charles Medbury. The company is installing a 25-ton mill to treat the ores by concentration. The property produces silver sulphide ore.

In the northern part of the State of Nayarit, the Rosa Morada property has been taken over by the Potrero company. This is a free-milling gold property and is fully equipped with stamp mill and cyanide plant.

Activity in San Lorenzo District

Lem Shattuck and associates, of Bisbee, Ariz., have opened up what promises to be a large copper deposit in the San Lorenzo district of the State of Sinaloa. They are down with an incline shaft to 200 ft. and have a vein 35 ft. wide of ore averaging 9 per cent copper, with substantial gold and silver content.

T. J. Wallace, who is developing a gold-silver property in the same district, has an incline shaft down about 100 ft. He has 8 ft. of $30 ore on the lowest level, and will soon be in the market for a mill.

Ships to Selby Smelter

In the Tamazula district of western Durango, at the Calera mine, owned and operated by London capital, gold bullion is being shipped monthly to the Selby smelter, near San Francisco, Calif. The operators are installing a 60-ton stamp mill and cyanide plant to take the place of the Gibson mill with which they have been working.

Resumption at Batopilas

In the Batopilas district several old mines are again producing. Francisco Ramirez has added a new group to his extensive holdings by recording the Dolores, composed of twelve contiguous claims. The ores are of gold and silver, and will be treated at the same mill as those of the Tres Hermanas mines. Facundo Gomez has applied for titles to a new property recorded as the Pompeya Sur. It is in the vicinity of the old Guadalupe and El Rosario mines.

NEVADA

No Dividend, No Mill for Divide

At a meeting of stockholders and directors of the Tonopah Divide Mining Co. held in Tonopah on March 7 the following board of directors was elected for the ensuing year: Mrs. E. B. Brougher, widow of the late H. C. Brougher, president; B. F. Edwards, first vice-president; W. J. Douglas, second vice-president; E. J. Erickson secretary and treasurer, William Watters superintendent. Contrary to local public opinion no dividend was declared and no plans announced for future mill construction. Ore shipment to the Belmont mill in Tonopah is to be increased from 60 to 100 tons per day. During 1922 18,885 tons of ore was milled with a gross value of $615,679.54, and net earnings were $238,433.43.

Mine developments during the past year were reported as satisfactory, with no new discoveries of importance. Total footage was 6,493 ft. Many branch veins, some of which contained high-grade ore, were developed during the year. These veins branch off the main north-west striking vein to the west and south-west. The main vein was cut on the 1,200 level and some incomplete development accomplished without finding ore of commercial grade.

On the 1,400 level the new crosscut toward the vein has not yet entered vein material on account of a change in dip of the vein from steeply to the north-east to a variable dip to the south-west below the 1,000 level. A water flow of 40,000 gal. per day was encountered on this level. This 1,400 work is regarded as very important and will be continued during 1923 in the hope of finding valuable orebodies below the water level. Some development work was done on the gold veins, which are the original veins of the district, without success, although this work is regarded as incomplete at present.

No attempt was made to estimate ore reserves as the shape of the ore bodies is irregular and the distribution of precious metal erratic.

UTAH

Ore Shipments

Shipments from Utah districts for the week ended March 9 follow:

Park City—Total 4,936 tons. The shippers were: Park-Utah, 2,189 tons; Park City Mining & Smelting, 1,122; Silver King Coalition, 1,013; Ontario, 353; Keystone, 250 tons.

Bingham — Total 94 cars. The shippers (excluding Utah Copper and Utah Consolidated) were United States Mines, 60 cars; Utah-Apex, 16; Bingham Mines, 10; Montana-Bingham, 8.

Eureka — Total 190 cars. The shippers were Chief Consolidated, 73 cars; Tintic Standard, 47; Victoria, 12; Iron Blossom, 12; Colorado, 11; Dragon, 10; Eagle & Blue Bell, 9; Swansea, 4; Mammoth, 3; Centennial-Eureka, 3; American Star, 2; Iron King, 2; Bullion Beck, 1; Tintic Drain Tunnel, 1.

NEW MEXICO

Leaching Plant Earns Enough to Cover Burro Mountain Expense

Since the shutdown of the Burro Mountain mine of the Phelps Dodge Corporation at Tyrone, the property has been earning its current expenses by the mine-water leaching plant. Operating expenses are light and the recovery is running about $1,000 per week at the current price of copper. The surrounding camps are being scavenged for their surplus scrap iron and tin cans to keep production going.

Small Operations Are Stimulated

The present prices of metals is encouraging small mining operations throughout New Mexico. Assayers and smelter representatives are busy and report a steady increase in shipments from mines recently shut down. There is a scarcity of skilled mine labor.

MONTANA

New Industrial Accident Ruling

The State Industrial Compensation Board announces new regulations that are especially interesting to operators of small mines. It is applicable to all employers under "plan No. 3." It provides that on and after Feb. 1, 1923, all payrolls running under $25,000 per year must be itemized. The name of the employee, his occupation and the wages paid during the preceding month must be given. Employers whose annual payroll is over $25,000 are not required to itemize such payrolls, but the books of all employers whose payrolls are not itemized will be audited by a representative of the department at stated periods. Hereafter if a man is injured or killed and his name does not appear upon the employers payroll, the board will decline to accept his claim for compensation and he then will have the right to bring suit in the ordinary courts.

Heretofore it has been the custom and the rule for an employer to report the number of his employees and the gross wages paid during the month. This system has permitted employers, who are so disposed, to cheat. The board has lately discovered that a considerable number of employers have reported only part of their employees. Later, if one of the employees was injured or killed, the board was obliged to accept the claim for compensation without knowing whether the premiums had actually been collected on such employee. This practice has resulted in discrimination against the employer who has honestly reported his full payroll. Most of the employers have done this, but a sufficient number have evaded, to result in the loss of many thousands of dollars in premiums each year the board believes.

Barnes-King Directors Re-elected

The annual meeting of the Barnes-King Development Co. was held in Kendall, Montana, March 7. Directors re-elected include: Charles W. Goodale, John E. Cosette, A. J. Davis, I. A. Heilbronner, Charles R. Leonard, F. R. Melcher, C. C. Swinborne, all of Butte, and T. A. Marlow of Helena, Montana.

Strike in Algonquin Mine

It has been reported that a rich silver vein has been found in the Algonquin mine of Philipsburg Mining Co. at Philipsburg. The property, which has not been operated for many years, was recently reopened. The strike was made on the 600-ft. level. The ore is reported as assaying more than 400 oz. silver per ton.

Anticipate "Conclusion" of Pittman Act

Due to the announcement of the smelting companies that they will not guarantee one dollar an ounce for silver after April 1, 1923, all of the lessees of Philipsburg district have been notified by the owners of the various properties to clean up all ores at once. There are more than eighty lessees operating at this time.

Goldsmith Mine Sold to Crystal Copper Co.

The Goldsmith mine, one of the oldest of the rich silver mines of the Butte district, changed hands recently. The deed was filed with the county clerk and recorder of Silver Bow County. It was signed by C. W. Ellingwood and wife and J. K. Heslet, trustee. The consideration given was $1, but cancelled internal revenue stamps to the amount of $200 indicate a much larger consideration.

This mine has been operated steadily for the past three years. Recently, the shaft, originally of two compartment, has been enlarged to three compartments by raising from the 500 level to the surface. They are now raising the shaft from 600 level to the 500 level. When this work is completed the present single drum hoist will be replaced by a new double drum electric hoist. The shaft will then be sunk from the 600 to the 700 level. The pump station on the 600 level has been altered and made ready for a new pump. Provision has been made for the storage of 22,000 gal. of water. The surface plant, has been remodeled and equipped with new machinery. Matt W. Alderson, manager, is very optimistic as to the future of the property.

IDAHO

Increased Mine Output for 1922

According to the recent report of Stewart Campbell, state mine inspector, the total value of all lead, silver, gold, copper, and zinc mined and marketed in Idaho during 1922 was $19,196,403, an increase in value of $2,632,389 over the production of 1921. The production of copper and zinc show a decided increase; gold decreased and lead and silver remained about the same as the 1921 production.

The schoolhouse in the model industrial town of Tyrone, N. M.

The 1922 production of silver was 6,149,336 oz., a decrease of approximately 35,000 oz. The value of the 1922 output of lead was $11,762,302 while the value of the 1921 output was $9,559,558. In quantity 1922 lead production was 205,132,588 lb. compared with 210,100,194 lb. 1921.

Lewiston Wants Mineral Survey

The Commercial Club of Lewiston, Idaho, has asked that the Bureau of Mines of the University of Idaho make an examination and report of the mineral deposits of Idaho County. This report is to be a preliminary step to securing exhaustive reports by independent mining experts. The purpose of the report will be to attract capital to the vast isolated gold-mining district of Central Idaho. Considerable good ore has been found but the high cost of transportation has retarded development.

Iron King Is Being Developed

Galena is scattered through the face of a drift following the vein in on the 400 level on the Iron King mine. The property lies in the same district as the Western Union and Galena mines near Wallace. Drifting has been in progress for a month. A. P. Reinardt controls the mine.

ARIZONA

Rich New Orebody in U. V. X.

The United Verde Extension company, operating at Jerome, has encountered a new body of rich ore on the 1,500 level that was previously unknown. This find occurs in a drift that is driven from the Edith shaft and contains ore for a distance of 40 ft. Samples have assayed 17 per cent copper and from 20 to 200 oz. silver. Nothing is known regarding the extent of this orebody, but it appears to be a lens formation, similar to the first deposit found at this property which made the mine.

Verde Central Development Progresses

The Verde Central drift on the 800 level of the mine at Jerome has left the ore at a distance of 550 ft. from the shaft, but the contact is being followed and the ore is expected to appear again as has been the case at other points along the drift. Much water has been encountered in the shaft, but that is being handled satisfactorily. A long prospect crosscut is being driven on the 105 level from the tunnel. A recent fire destroyed the company's change house, entailing a loss of about $3,000, which included the clothing of the men that were on shift.

JOPLIN-MIAMI DISTRICT

200-Ton Concentrator Replaces One Burned

The Mogul Mining Co. has taken a lease on a tract near Picher adjoining the one on which its mill burned on Feb. 27, and will erect on it a new 200-ton concentrator immediately. The company has a 10-year lease at 10 per cent royalty on the new tract, whereas only two more years remained on the original Mogul lease. It expects to tap the Mogul orebodies from the new lease, however. The company received $23,800 in insurance whereas the plant was making a net profit of $500 a day at the time of the fire. A. E. Dunlap, of Miami, Okla., is general manager.

Peacock-Badger District Revives

The Barnsdall Zinc Co. has started operation of the Peacock mill in the Peacock-Badger field, northwest of Joplin, on Spring River, after several months of drill prospect work. Unwatering was completed several months ago, and although some of the workings of the mines will be under the river, the water problem will not be nearly so serious as in some other sections of the field.

Lone Star Pumped Out

The Lone Star mine at Neck City has been placed in operation again after being down for three years. Two "Texas" Leyner pumps and one Pomona pump are now being used to keep the drifts clear of water, and another Pomona will be installed to make it possible to sink to the 200 ft. level. Operations for the present will be carried on at 150 ft. James Crissman, of Neck City, is manager.

Chamber of Commerce, Carthage, Mo., Has Substantial Boosting Scheme

The Carthage, Mo., chamber of commerce is organizing a drilling company with an initial paid-up capital of $5,000, to do drilling in the vicinity of Carthage for zinc and lead. In the past three or four good producers have been developed near this town and it is believed other good deposits remain to be located. James Luke, one of the country's most prominent capitalists, is at the head of the mining committee of the chamber of commerce, which is promoting the company. If strikes are made it is planned to sub-lease, as was done successfully by Webb City business men several years ago.

MICHIGAN

Consolidation Plans Progress

Announcement of the plan of consolidation of the Ahmeek, Allouez, Osceola, and Centennial mining companies with the parent company, Calumet & Hecla, will be made the latter part of April.

The consolidation plan involves, also, the inclusion of a fabricating plant, which will be acquired to insure a market for the consolidated company's raw material. The Detroit Copper & Brass Rolling Mills, one of the largest and best-established plants in the middle west, probably will be taken over.

Only Best "Rock" Is Mined

The remarkable change in mining in the Michigan copper district is revealed by Isle Royale's showing of 26.92 lb. of refined copper to the ton of rock treated in 1922. This is an increase in yield since 1919 of 9 lb. per ton. Low-grade rock is no longer mined, the comparatively poor stretches being left untouched, and close selection is employed. Isle Royale has obtained this high yield at even a lower cost per ton than either in 1921 or 1920, and at a cost equal to that in 1919. The only essential in this method of mining is that ample openings be provided, and this is particularly necessary in Isle Royale, as the lode is bunchy. From 65 to 75 per cent of the ground opened, however, is worth stoping.

Iron Mines Want Workers

The Bristol Mining Co., operating on the Menominee Range, has announced that it will at once add 140 men to its present force of employees, putting on a night shift. For the last several years this property has worked only one shift. The bettered ore market is the reason for this change.

The Forbes mine on the same range, that has been idle since 1920, is to resume operations as soon as it can be placed in condition, and miners can be secured. This property is operated under lease by the Jones & Laughlin Co., well known miners and steel manufacturers of Pittsburgh. Mark Elliott, representative of the company in the Lake Superior district, announces the company is in the market for miners and common laborers to man this property, which is located near Iron River.

TEXAS

Marked Activity in Carrizo District

By James P. Porteus

Mining in the Carrizo district, in the vacinity of Allamore, Hudspeth County, is quite active. The ores are principally silver-copper and are shipped to the El Paso smelter. The Mohawk mine is working several veins showing high silver assays, with copper and some lead. Fifteen men are working. Stanley Hackett, is president and A. L. Cox, treasurer. A compressor and air drill equipment have been ordered from dealers in El Paso.

About three miles east of the Mohawk is the old Hazel mine, with a record of over 1,000,000 oz. of silver taken out about 25 years ago. It is reported that development work has revealed new veins and it is expected that mining will begin here at an early date.

The Circle mine, two miles north of the Mohawk, owned by Melton Brothers, is shipping 50-oz. silver-copper ore to the smelter. They have sunk an inclined shaft 70 ft. on a 6-ft. vein. At this depth the vein straightened and a vertical shaft has been started to facilitate hoisting.

At the Sancho Panza mine, five miles north of Allamore, a body of copper carbonate, carrying silver, has been opened by manager James T. Mace. This ore will be handled by leaching and a 50-ton plant has been ordered and will be installed at once.

The Copper Plate mine midway between Allamore and Van Horn is working a small force doing development work upon four claims. The ores are chalcopyrite and oxides carrying silver. W. H. Pollard, the owner is in charge.

In the Quitman Mountains, nine miles west of Sierra Blanca, is the old Bonanza mine owned by Love brothers. This mine has been a good producer of zinc in times past and recent work is reported to have opened ores that will be shipped to Oklahoma smelters from Lasca station on the G. H. & S. A. railroad.

New Sulphur-Loading Plant Handles 540 Tons Per Hour

The new sulphur-loading plant of the Texas Gulf Sulphur Co. at Galveston, Tex., has been completed, and the first ship was loaded on Feb. 28. This was the motorship "Glensdaurel," which carried 3,500 tons of crude sulphur for Atlantic ports. The plant consists of two concrete storage bins, 600 ft. long and 60 ft. wide, holding 35,000 tons of crude sulphur, a series of belt conveyors that carries the material to the top of a tower, whence it is run into the hold of a ship through an aluminum spout. The main conveyor runs the full length of the bins, and on either side of it is a railway track. Two locomotive cranes and a movable hopper straddle the conveyor. The cranes unload the gondolas into the bins and also feed the hopper from the bins. All machinery is electrically driven. Sulphur was loaded at the rate of 540 long tons per hour during the initial run.

THE MARKET REPORT

Daily Prices of Metals

Mar.	Copper, N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
15	16.75	49.00@49.375	51.50	8.25	8.25	7.65@7.95
16	16.75	49.00@49.375	51.375	8.25	8.25	7.65@7.95
17	16.875	49.00	51.00	8.25	8.25	7.65@7.95
19	17.00	48.125	50.125	8.25	8.25	7.65@7.95
20	17.00	47.00@47.625	49.25	8.25	8.25	7.65@8.00
21	17.00@17.125	46.50@46.875	48.625	8.25	8.25	7.65@8.00

*These prices correspond to the following quotations for copper delivered: March 15th and 16th, 17.00c.; 17th, 17.125c.; 19th and 20th, 17.25c.; 21st, 17.25@17.375c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Tin quotations are for prompt deliveries. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

March	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
15	74 1/2	74 7/8	81 3/4	231 3/4	232 1/4	28 7/8	28 3/4	37 5/8	37 3/4
16	75 3/8	75 7/8	82 1/2	232	232	28 3/4	29 1/8	37 3/4	37 7/8
19	76 1/4	77	83	225 1/2	226 1/2	28 3/4	29	37 1/4	37 3/8
20	75 7/8	76 1/2	83	222 7/8	223 1/2	29	29	37 3/8	37 3/8
21	75 1/4	76	83	219 1/2	220 1/4	28 5/8	28 5/8	36 7/8	36 7/8

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver and Sterling Exchange

Mar.	Sterling Exchange "Checks"	Silver			Mar.	Sterling Exchange "Checks"	Silver		
		New York Domestic Origin	New York Foreign Origin	London			New York Domestic Origin	New York Foreign Origin	London
15	4.69 1/8	99 1/8	67 3/8	32 3/8	19	4.70	99 1/8	67 1/8	32 1/16
16	4.68 3/4	99 1/8	67 1/2	32 1/4	20	4.69 1/4	99 1/8	67 1/8	32 1/2
17	4.69 1/4	99 1/8	67 1/2	32 5/16	21	4.68 1/2	99 1/8	67 3/8	32 7/16

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Metal Markets

New York, March 21, 1923

The inactivity in the metal markets has continued though prices show no tendency to decline, owing to the continued excellent business of metal consumers and the large amount of metal they are taking on a contract basis.

Copper

With practically all producers asking 17⅜c. delivered, today, copper is quoted at the highest price since October, 1920, when it passed that level on its downward movement. It is interesting to note that until yesterday the resumption of the advance was not inspired so much by the demands of domestic consumers as by speculative dealings abroad. When the price wavered at 17c. and was weak in London two or three weeks ago, there was considerable short selling on the London market by international interests who thought a reaction was due. The copper which they sold short was quickly picked up. However, the reaction in price was not so marked nor so long continued as they expected and in seeking to cover at around 16.60@16.75c. they quickly pushed the price back to the 17c. level and even beyond, for producers had little to offer. Yesterday and today, domestic consumers are again active buyers. Some manufacturers report a slight slowing up of orders owing to the sudden advance which they have been compelled to make in their prices for finished products in which the price of raw copper is the governing factor. They are still working at or near capacity but fear that if the price continues to climb they will not be so busy in the summer.

Lead

The official contract price of the American Smelting & Refining Co. continues at 8.25c., New York.

Demand continues good but consumers have a decided aversion to paying fancy prices, and supplies of metal are adequate. Marked premiums continue to be asked for spot delivery but there is very little call for anything earlier than April so that these quotations are nominal except possibly for less-than-carload lots. Some producers continue to quote 8.30 and 8.35c., New York, for April delivery but report the market unresponsive, so that those who are selling for 8.25c. are getting all of the business. Followers of the market are watching London closely, for they feel that should there be another decline of importance there, following that of today, the New York market might be affected. It seems there is some talk of strikes among the building trades in England, and the effect that these might have on consumption is possibly being discounted. There are indications that the market price of lead will not advance further, but on the other hand there are no signs of any important decline. It is possible that the storage-battery manufacturers will not be such large consumers after the spring automobile business is over but on the other hand production may fall away somewhat when the warm weather attracts labor away from the mines and smelters.

The St. Louis market has been quiet with producers offering lead at 8.25@8.30c., the higher price not being generally accepted. Premiums on corroding lead in the Middle West are as high as $4 per ton.

Zinc

Demand has not been quite so active as last week, but prices are substantially unchanged. There is a marked scarcity of prompt zinc which is reflected in high prices, 7.90c@8c. From this level, prices range down to 7.65c. for July-August. Sales are fairly well divided over the intervening months so that an average of the extremes fairly represents the total tonnage sold. Production is now considered to be near capacity, and as long as present demand continues, weakness in the market is not expected. High-grade is 8.75@9c.

Tin

The market has varied widely owing to the usual speculative influences. Buying by consumers is not active, but prices below 50c. for Straits prove attractive to some. Forward metal is quoted at about the same prices as spot.

Arrivals of tin, in long tons: March 12th, Straits, 155; 14th, Straits, 600; Liverpool, 50; 15th, London, 25; Liverpool, 175; 16th, Straits, 40; 19th, Liverpool, 350; Straits, 1,785; 20th, Liverpool, 150; total so far in March, 6,267.

Gold

Gold in London: March 15th, 88s. 8d.; 16th, 88s. 8d.; 19th, 88s. 4d.; 20th, 87s. 8d.; 21st, 88s. 2d.

Stock of money in the United States, March 1: Gold coin and bullion, $3,960,955,432; standard silver dollars, $464,464,404; subsidiary silver, $268,891,383; United States notes, $346, 681,016; Federal Reserve notes, $2,647,563,480; Federal Reserve Bank notes, $34,036,000; National Bank notes, $767,043,704; total, $8,489,635,419. In circulation, per capita, $41.61. The gold stock increased by $23,000,000, and the silver stock by $10,000,000 during February, while the outstanding notes increased $15,000,000.

Foreign Exchange

On Tuesday, March 20, cable quotations on francs were 6.525c.; lire, 4.845c.; marks, 0.0048⅛c.; and Canadian dollars, 2¼ per cent discount.

Silver

The London market has shown no definite tendency, but has fluctuated within a range of ½ penny, with China and India operating on both sides of the market and the Continent selling limited amounts. America has been a reluctant seller in London, as sales for San Francisco delivery have yielded a better price than the London parity, with the result that the New York market has held higher than the equivalent of the London spot quotation.

Mexican Dollars—March 15th, 51⅝; 16th, 51½; 17th, 51½; 19th, 51¼; 20th, 51⅜; 21st, 51⅝.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—General market for 99 per cent grade, 25½@26c. per lb.; 98 per cent, 24½@25c. London quotations, £91@£105.

Antimony — Chinese and Japanese brands, 8¾c. W.C.C., 9c. Cookson's "C" grade, spot, 9¾@10¼c. Chinese needle antimony, lump, nominal, 6c. per lb. Standard powdered needle antimony, 200 mesh, at 6½@7c. per lb. White antimony oxide, Chinese, guaranteed 99 per cent Sb_2O_3, 8@8½c.

Bismuth—$2.55 per lb. London, 10s.

Cadmium — $1.10 per lb. London quotes 4s. 6d. @ 5s. 6d.

Iridium—$260@$275 per oz.

Nickel—25@30c. per lb. for 99 per cent virgin metal.

Monel Metal—Shot and blocks, 32c. per lb.; ingots, 38c.; f.o.b. W. Va.

Osmium—$80@$85 per oz., Los Angeles.

Palladium—$79 per oz.

Platinum—$110 per oz. London, £22½.

Quicksilver—$72 per 75-lb. flask. San Francisco wires $71.50. London £10 10s.

Ruthenium—$40@$45 per oz.

Selenium—$2 per lb.

The prices of **Cobalt, Molybdenum, Radium, Rhodium, Tellurium** and **Thallium** are unchanged from prices given March 3.

Metallic Ores

Chrome Ore—Indian chrome ore, $20.50 per ton, c.i.f. Atlantic ports. Rhodesian and New Caledonian, $24@$26 per ton.

Manganese Ore—35@40c. per long ton unit, seaport, plus duty.

Molybdenum Ore—75@85c. per lb. of MoS_2 for 85 per cent MoS_2 concentrates.

Tungsten Ore — Wolframite, $8@$8.50; scheelite, $8.50@$9 per unit of WO_3 f.o.b. New York.

Iron Ore, Magnetite, Tantalum, Titanium, Uranium, Vanadium, and **Zircon Ore** are unchanged from the quotations published March 3.

Zinc and Lead Ore Markets

Joplin, Mo., March 17—Zinc blende, per ton, high, $52.10; basis 60 per cent zinc, premium, $50; Prime Western, $48.50; fines and slimes, $47@$44; average settling price, all zinc ores, $46.86.

Lead, high, $123.50; basis 80 per cent lead, $122.50; average settling price, all lead ore, $118.32 per ton.

Shipments for the week: Blende, 17,543; lead, 2,180 tons. Value, all ores the week, $1,082,110.

Buyers and sellers compromised on offerings today for next week's purchase at $50 for premium and $48.50 for Prime Western, closing an all-day holding by sellers for $52 and $50 basis. The purchase is the largest of record, being 28,410 tons.

Platteville, Wis., market report not received on going to press.

Non-Metallic Minerals

Asbestos—Crude No. 1, $500; No. 2, $250@$325; long spinning fibers, $135@$200; magnesia and compressed sheet fiber, $100@$150; shingle stock $65@$85; paper stock, $35@42; cement stock, $20@$25; shorts, $9@$14—all per short ton, f.o.b. mines, Quebec, Canada.

Rhodesian No. 1 crude, $375; No. 2, $250; inferior grade, $200—all c.i.f. Atlantic ports per short ton.

Magnesite — Dead-burned magnesite grains, $40 per net ton, f.o.b. Baltimore; $40@$42, Chester, Pa.

Crude, $14 per ton; 85 to 90 per cent MgO calcined lump, $32.50@$38 per ton; calcined ground, in paper sacks, 90 per cent through 200 mesh, $44@$48 per ton—all f.o.b. California points.

Grecian caustic-calcined and ground, $51@$52 per ton, f.o.b. cars, Atlantic seaboard.

Bauxite, Barytes, Chalk, China Clay, Diatomaceous Earth, Emery, Fluorspar, Fuller's Earth, Graphite, Gypsum, Limestone, Manjak, Mica, Monazite, Phosphate, Pumice, Pyrites, Silica, Sulphur, and **Tripoli** are unchanged from the March 3 prices.

Mineral Products

Arsenious Oxide (white arsenic)—14@15c. per lb. for prompt, nominal. June, 12½c. 2d half 1923, 11c.

Sodium Sulphate—$26@$28 per ton.

Potassium Sulphate, Sodium Nitrate, and **Copper Sulphate** are unchanged from quotations of March 3.

Ferro-Alloys

Ferromanganese — Domestic, 78@80 per cent, $120 per gross ton, f.o.b. furnace. Spiegeleisen, 19@21 per cent, $40, f.o.b. furnace; 16@19 per cent, $39.

Ferrosilicon—50 per cent $86@$89 per gross ton, delivered.

Ferrocerium, Ferrochrome, Ferro molybdenum, Ferrotitanium, Ferrotungsten, Ferro-uranium, and **Ferrovanadium** are unchanged from the prices published March 3.

Metal Products

Copper Sheets—Base price 25½c. per lb. Wire, 19⅜c.

Nickel Silver—30¾c. per lb., for 18 per cent nickel Grade "A" sheets.

Yellow Metal — Dimension sheets, 22½c. per lb.; rods, 19½c. per lb.

Zinc Sheets—Base price, $10 per 100 lb., East St. Louis.

Lead Sheets—Full, $10.25; cut, $10.50 per 100 lb.

Refractories

Bauxite Brick, Chrome Brick, Chrome Cement, Magnesite Brick, Magnesite Cement, Silica Brick and **Zirkite** are unchanged from the March 3 prices.

The Iron Trade

Pittsburgh, March 20, 1923

Prices of finished-steel products for late delivery are unchanged. For early deliveries premiums are tending to increase. There is increasing doubt whether the steel market is altogether as strong as appears on the surface, there being an appearance of scarcity whereas deliveries are so heavy that an actual scarcity seems almost impossible.

Production of steel is at the highest rate since the Armistice, and would be higher still if there were a better labor supply. Opinion in the trade is that the Steel Corporation will soon announce another general wage advance.

The Lake Superior iron-ore market for the season has not opened, but it is practically assured that there will be a 50c. advance, restoring the 1921 price schedule and making Mesabi nonbessemer $5.55, f.o.b. Lake Erie docks.

Pig Iron—On a sale of 2,000 tons for second quarter, bessemer is up $1 to $31, Valley. Basic and foundry are nominally $30, Valley, with rumors of $1 more having been done.

Connellsville Coke—Contracting for second quarter is now ended. Spot furnace, $7.25; spot foundry, $8.25@$8.75.

Facts for the Stockholder

X—Ray Consolidated Copper Co.

THE RAY CONSOLIDATED COPPER CO. was incorporated in Maine, May, 1907. During 1911 it absorbed the property of the Gila Copper Co., paying therefor 200,000 shares of its capital stock, and thereby increasing its ore reserves 15,989,000 tons averaging 2.04 per cent copper. In 1912 it acquired control of the Ray Central Copper Co. through an exchange of stock, thus increasing its holdings by 207 acres containing ore reserves amounting to 7,384,000 tons averaging 2.51 per cent copper, of which 673,000 tons was of high grade and averaged 5.83 per cent. In 1917 it acquired a one-third interest in the Gallup-American Coal Co. It owns the entire capital stock of the Ray & Gila Valley Railroad Co., which connects Ray with Kelvin and Ray Junction, the latter being the point at which it joins the Arizona Eastern.

Its property includes 1,971 acres of mineral land in the Mineral Creek mining district, at Ray, Pinal County, Ariz.; 127 acres at Ray Junction, used for railroad yards, and 4,164 acres at Hayden, used for milling and smelter purposes. At Hayden, 536 acres are leased to the American Smelting & Refining Co. as a site for its smelting plant.

The ore deposit is similar to those at Miami, Bingham, Ely, and Morenci. It is 150 to 500 ft. thick, 1,000 to 3,000 ft. wide, and about 9,000 ft. long. The main ore zone is a metamorphosed, iron-stained schist, intruded by a granite mass. The more important ore values are in the form of secondary chalcocite. The property has been developed by both extensive underground workings and churn-drill holes. Total ore reserves are estimated at 82,652,220 tons averaging 2.07 per cent copper.

The orebodies are developed by several shafts, and about 135 miles of underground workings, about 70 miles of which have been destroyed by mining operations. Ore is hoisted from a maximum depth of about 300 ft.

Equipment includes a 10,000-ton concentrator at Hayden, about 16 miles from the mine; and a power plant of about 10,000 hp. capacity. Concentrates are smelted by the American Smelting & Refining Co. at rates and under conditions favorable to the mining company.

Production in recent years has been as follows, in millions of pounds: 61.1 in 1915; 75.2 in 1916; 86.8 in 1917; 82.4 in 1918; 46.7 in 1919; 48.8 in 1920; 10.4 in 1921, operations being discontinued in April; 16.0 in 1922, operations being resumed in April.

Capital stock outstanding consists of 1,577,179 shares, par value $10. Authorized capital, 1,600,000 shares. There is no funded debt. At the close of 1921, current assets amounted to $6,727,000, compared to current liabilities of $586,000, net working capital standing at about $6,140,000. Net assets applicable to capital stock amounted to about $19 a share.

Net income increased from $1,900,000 in 1912 to $4.600,000 in 1915, jumped to $12,000,000 in 1916 and $10,400,000 in 1917, fell off to $4,800,000 in 1918, $1,600,000 in 1919, $900,000 in 1920, and ran into a deficit of $1,600,000 in 1921. During the latter half of 1922, earnings have increased rapidly. For the quarter ended Dec. 31, 1922, the income was $201,903, after expenses and depreciation, equivalent to about 12c. a share. This compares with a total income of $57,800, or about 4c. a share, earned during the previous quarter.

The dividend record is as follows: $1.125 a share in 1913, $0.75 in 1914, $1.25 in 1915, $2.75 in 1916, $4.20 in 1917, $3.25 in 1918, $2 in 1919, $1 in 1920, the last payment being 25c. a share, Dec. 31, 1920.

No. 2 mine has been operating at capacity since November, 1922. During the quarter ended Sept. 30, 1922, the company milled 436,000 dry tons, averaging 1.57 per cent copper, an average daily tonnage of 4,739, compared with 2,996 for the preceding quarter. Net cost was 13.18c. a pound, compared with 16.92c. for the previous quarter.

Price range of stock has been: High, 37 in 1916; low, 10 in 1920; closing price March 19, 1923, 16.

INVESTIGATOR.

High Prices Interfere With French Copper Market

Paris, March 5—The present depression of French exchange is accentuating for French consumers the rise of copper prices on the New York and London markets. The present prices are considered here much too high, and, although the impression is that they will go still higher, purchasers are proceeding very cautiously and cover only their immediate requirements. Besides, the industrial demand in France is rather restricted.

Formerly, users of raw copper in France, besides holding a working stock of metal, were accustomed to carry a speculative stock purchased at prices deemed sufficiently low to warrant a sure profit within more or less time. French industrialists have now completely renounced these methods and simply cover themselves as soon as they have booked an order, purchasing at the same time sterling or dollars.

The high prices of copper were particularly unwelcome in France at the present time, owing to the large tonnage of this metal which will be required for the contemplated projects of electrification of railways, of equipment of waterpower and of renewal of telephone lines. The question of a substitute metal has been examined and the opinion is being held that aluminum, of which France owns important ore reserves, would be a suitable substitute. The Compagnie des Chemins de Fer du Midi has just ordered, to provide for the electrification of its lines, 2,000 tons of aluminum, which will replace a proportionate quantity of copper.

The war stocks of brass (laiton) being now practically exhausted, brass makers are at last emerging from their long period of inactivity and most of them have work on hand for the next four or five months.

LEAD ALSO AFFECTED

High prices have caused a considerable reduction of the demand for lead. Besides, the prospects of consumption of the metal are at the present time much less encouraging than they were last year: the principal reason for this is a reduction in the consumption of lead in the devastated areas, owing to lack of credits. Then, too the competition of iron with lead pipes is asserting itself.

Chile's Nitrate Trade in December

Nitrate exported during December from all of Chile totaled 2,315,471 metric quintals (metric quintal = 220.46 lb.), of which the Province of Tarapaca exported 867,876 metric quintals, according to *Commerce Reports*. Exports for the month to the United States and Hawaii totaled 486,632 metric quintals, with a value of $2,444,913 American currency. The sales of nitrate for the six elapsed months of the fiscal year 1923 (that is, from July 1 to Dec. 31, 1922) totaled 15,035,035 metric quintals. This equals the minimum estimated sales for the fiscal year and is 70 per cent of the maximum estimated sales of 22,000,000 metric quintals.

Of the fifty-three nitrate plants in operation in Chile, thirty-three are in Tarapaca. Four additional plants began work in December, so that ninety-six still remain idle throughout the republic. Several additional plants were expected to begin operations in January. Approximately 400 workmen arrived in Tarapaca during December and were hired in the different nitrate plants.

South Australia Copper for U. S.

On Jan. 8 336,115 lb. of blister copper slabs, valued at £10,040, was sent from South Australia to the United States, according to the U. S. Department of Commerce. This is believed to be the first shipment of South Australian copper to go to the United States, and it is expected that other shipments will follow. The Wallaroo & Moonta Mining Co., which supplied the copper, is one of the oldest copper mining companies in Australia and has operated its mines for more than sixty years. During the past three years this concern has been intermittently closed several times on account of labor and wage troubles, but is now operating at nearly full capacity.

COMPANY REPORTS

Nevada Consolidated Copper Co.

A statement of the Nevada Consolidated Copper Co. operations for the fourth quarter of 1922 reports that production of copper for the quarter was 7,448,465 lb., compared with 4,778,300 lb. for the preceding quarterly period.

A total of 131,416 tons, dry weight, of Nevada Consolidated ore, averaging 1.62 per cent copper, was milled, and 38,119 tons of Ruth mine direct-smelting ore, averaging 6.09 per cent copper, was received at the smelter. In addition to the company ores received at the smelter, 2,956 dry tons of custom ore, averaging 5.20 per cent copper, and 471 dry tons of custom matte, averaging 14.43 per cent copper, were purchased and smelted.

The cost of production per pound of copper, including depreciation and all fixed and general overhead expenses, and before crediting precious-metal values and miscellaneous earnings, was 16.26c. per lb. If deduction were made from the cost stated for depreciation currently charged, but for which there was no cash outlay, and credit applied for the value of gold and silver and all miscellaneous income, other than railway dividends, the net cost so derived would be 12.10c. per net lb. of copper produced.

The financial outcome of operations, based upon an average carrying price of 14.05c. per pound of copper, is shown in the summary statement submitted below. The operating loss, as stated, includes current charges for depreciation of plant and equipment and the usual fixed and general items of expense:

Operating loss	$164,763.78
Value of gold and silver and miscellaneous earnings, including Nevada Northern Railway dividend	581,845.50
Increase in earned surplus	$417,081.72

Reconstruction of the concentrator, which was destroyed by fire in July, 1922, is progressing as favorably as weather conditions will permit. At the end of the preceding quarter sufficient equipment had been installed to treat an average of one thousand tons of ore per day. Additional equipment installed during this current quarter increased the capacity of the mill to three thousand tons daily, and at the date of this report completed sections of the mill are in operation having a capacity of about five thousand tons of porphyry ore per day, with an average recovery of over 80 per cent. The treatment of the concentrates product of this tonnage, including the metal recovered from the Ruth direct-smelting ore averaging 6 per cent copper, will give a production of approximately 4,500,000 lb. of copper per month.

Building construction and machinery installation will continue and additional mill sections will be turned over to operations as completed, with the expectation that by April 1 the output of mill and smelter will be increased to above 5,000,000 lb. of copper per month.

Ray Consolidated Copper Co.

Copper; Arizona

A report of operations of Ray Consolidated Copper Co. covering the fourth quarter of the year 1922 states that in addition to copper derived from concentrates there was a total of 102,047 lb. of copper contained in ore sent direct to the smelter. This, combined with the copper contained in the concentrates, brings the total net production from both sources, after allowing smelter deduction, up to 12,249,695 lb., as compared with 10,079,470 lb. for the previous quarter.

There was milled 496,700 tons, dry weight, of ore averaging 1.60 per cent copper, an average daily tonnage of 5,399 tons as compared with an average of 4,739 tons per day for the previous quarter.

The mill recovery was 79.53 per cent of the total copper contained in concentrating ores, as compared with 75.23 per cent for the previous quarter.

The average gross cost per net pound of copper produced was 12.5c. This cost includes regular current charges for depreciation of plant and equipment and all items of fixed and general expense, and is exclusive of credit for miscellaneous income and precious-metal values. By applying credit for the value of gold and silver recovered and for the miscellaneous earnings for the period and deducting the charge for depreciation, for which there was no cash expenditure, a net cost of 11.3c. per lb. of copper is derived.

The financial results of operations for the quarter, after the inclusion of current charges for depreciation as stated, are as follows:

Operating profit	$165,537.61
Miscellaneous income and gold and silver	36,365.19
Net surplus for quarter	$201,902.80

The average carrying price of copper was 13.847c., compared with 13.760c. for the previous quarter.

Chino Copper Co.

Copper; New Mexico

A statement of the operations of the Chino Copper Co. for the fourth quarter of 1922, states that at Hurley four sections of the mill, together with the necessary portion of the regrinding section, were in operation during the entire quarter. At Santa Rita the eighth shovel was placed in operation on Oct. 19 and the ninth shovel was placed in operation on Nov. 4.

The net production of copper for the quarter contained in concentrates from mill operations, after smelter deductions, was 12,545,865 lb. compared with 9,208,275 lb. for the previous quarter.

The total amount of ore, dry weight, treated by the mill for the ninety-two days operated during the quarter was 592,834 tons, or an average of 6,444 tons per operating day, the average grade being 1.61 per cent copper, compared with 1.49 per cent copper for the preceding quarter.

The gross cost per pound of net copper produced from mill operations was 12.53c. This cost includes charge for plant depreciation and all other items of fixed and general expenses, and is exclusive of credit for precious metal values and miscellaneous income. If the accruing credits for gold and silver and for miscellaneous earnings were applied, and the current charges for depreciation, for which there was no cash outlay, were excluded, the net cost would be stated as 11.38c. per lb. of copper produced.

Based on an average carrying price of 13.81c. per lb. of copper, and including current charges for depreciation, as stated, the results of operations for the quarter were:

Operating profit	$161,016.06
Miscellaneous income, including value of precious metals	21,612.49
Operating gain for quarter	$182,628.55

There was removed by steam shovels at Santa Rita a total of 764,934 cu.yd. of ore and overburden, or an average of 254,978 cu.yd. per month, as compared to a total of 682,635 cu.yd., or an average of 227,545 cu.yd., per month for the third quarter. Of the total material removed, 392,983 cu.yd. was stripping, the remainder being equal to 698,113 tons of ore, of an average grade of 1.50 per cent copper. The difference between the tons of ore mined and the tons of ore milled is accounted for by low-grade oxidized ore sent to storage.

MINING STOCKS

Week Ended March 17, 1923

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Ahmeek	Boston	83	80	81	Mar. 23, Q	$1.00
Alaska-Br. Col.	N. Y. Curb	2⅜	2¼	2⅜		
Allouez	Boston	30	28	29½	Mar. '19	1.00
Anaconda	New York	52½	50	51½	Nov. '20, Q	1.00
Arcadian Consol.	Boston	3⅜	3⅛	3⅛		
Ariz. Com'l.	Boston	13⅜	12⅝	13⅜	Oct. '18, Q	0.50
Bingham Mines	Boston	17⅜	17⅛	17⅜	Sept. '19, Q	0.25
Calumet & Arizona	Boston	64	61½	62½	Dec. '22, Q	0.50
Calumet & Hecla	Boston	395	385	390	Mar. '23, Q	7.00
Canada Copper	N. Y. Curb	*6	*4	*5		
Centennial	Boston			13½	Dec. '18, SA	1.00
Cerro de Pasco	New York	48⅛	47	48	Mar. '21, Q	0.50
Chile Copper	New York	29⅛	28⅜	29		
Chino	New York	30⅛	29½	30⅛	Sept. '20, Q	0.37
Copper Range	Boston	44½	43	43½	Mar. '22, Q	1.00
Crystal Copper	Boston Curb	1 1/16	1⅛	1 1/16		
Davis-Daly	Boston	4⅛	3½	4	Mar. '20, Q	0.25
East Butte	Boston	10½	9⅛	10	Dec. '19, A	0.50
First National	Boston Curb	70	65	65	Feb. '19, SA	0.15
Franklin	Boston	2⅛	2⅛	2⅛		
Gadsden Copper	N. Y. Curb			95		
Granby Consol.	New York	29⅛	28⅛	29⅛	May '19, Q	1.25
Greene-Cananea	New York	32	30	31	Nov. '20, Q	0.50
Hancock	Boston	3⅛	3	3⅛		
Howe Sound	N. Y. Curb	4⅛	3⅛	3⅛	Jan. '21, Q	0.05
Inspiration Consol.	New York	41	39½	40⅛	Oct. '20, Q	1.00
Iron Cap	Boston Curb	8⅛	8	8⅛	Sept. '20, K	0.25
Isle Royale	Boston	31	30	30⅛	Mar. '23, Q	0.50
Kennecott	New York	43⅛	41⅛	42⅛	Jan. '23, K	0.75
Keweenaw	Boston	2⅛	1⅛	1⅛		
Lake Copper	Boston	4⅛	4	4⅛		
Magma Copper	New York	36⅛	35⅛	35⅛	Jan. '19, Q	0.50
Mason Valley	N. Y. Curb	2⅛	2⅛	2⅛		
Mass Consolidated	Boston	3⅛	3⅛	3⅛	Nov. '17, Q	1.00
Miami Copper	New York	29⅛	28⅛	29	Feb. '23, Q	0.50
Michigan	Boston	4	3	3		
Mohawk	Boston	64⅛	63⅛	64	Nov. '22, Q	1.00
Mother Lode Coa.	New York	12⅛	12⅛	12⅛	Mar. '23, K	0.50
Nevada Consol.	New York	17⅛	16⅝	16⅛	Sept. '20, Q	0.25
New Cornelia	Boston	23	22	22	Feb. '23, Q	0.25
North Butte	Boston	10⅞	10⅛	10⅜	Oct. '18, Q	0.25
Ohio Copper	N. Y. Curb	*98	*83	*86		
Old Dominion	Boston	30	28⅛	30	Dec. '18, Q	1.00
Osceola	Boston	42	40	40	Mar. '23, K	1.00
Phelps Dodge	Open Mar.	†185	†175		Jan. '23, Q	1.00
Quincy	Boston	46⅛	44⅛	45	Mar. '20, Q	1.00
Ray Consolidated	New York	16⅛	15⅛	15⅜	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	2⅛	1⅞	2⅛		
St. Mary's Min. Ld.	Boston	50	49	49	Mar. '23, K	3.00
Seneca Copper	Boston	11⅛	11⅛	11⅛		
Shannon	Boston	1⅛	*90	.90	Nov. '17, Q	0.25
Shattuck Arizona	New York	9⅞	9⅛	9⅜	Jan. '20, Q	0.25
South Lake	Boston	†1	†*60	*50		
Superior & Boston	Boston	2⅛	2⅛	2⅛		
Tenn. C. & C. cfs.	New York	12⅛	12	12⅛	May '18, I	1.00
Tuolumne	Boston	*49	*47	*47	May '13,	0.10
United Verde Ex.	N. Y. Curb	*36	*31⅛	*35⅛	Nov. '22, Q	0.25
Utah Consol.	Boston	2⅛	2⅛	2⅛	Sept. '18,	0.25
Utah Copper	New York	73⅛	71⅛	73	Dec. '22, Q	0.50
Utah Metal & T.	Boston	1⅛	1⅛	1⅛	Dec. '17,	0.30
Victoria	Boston	2	2	2		
Winona	Boston	1⅛	1⅛	1⅛		
Wolverine	Boston	11⅛	11⅛	11⅛		
NICKEL-COPPER						
Internat. Nickel	New York	15⅛	15	15⅛	Mar. '19,	0.50
Internat. Nickel, pfd.	New York	76	75	75	Feb. '23, Q	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	5⅛	5⅛	5⅛		
National Lead	New York	132⅛	129	129	Dec. '22, Q	2.00
National Lead, pfd.	New York	112	112	112	Mar. '23, Q	1.75
St. Joseph Lead	New York	22⅛	21⅛	21⅛	Dec. '22, Q, X	0.50
ZINC						
Am. Z. L. & S.	New York	18⅛	17	18⅛	May '20,	1.00
Am. Z. L. & S. pfd.	New York	56	55	55	Nov. '20, Q	1.50
Butte C. & Z.	New York	10⅛	10⅛	10⅛	Mar. '23,	0.50
Butte & Superior	New York	35⅛	33⅜	35⅛	Dec. '22,	0.50
Callahan Zn-Ld.	New York	11⅛	10⅛	10⅛	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb	179⅛	178	179⅛	Feb. '23, Q	2.00
Yellow Pine	Los Angeles	*72⅛	*55	*55	Sept. '20, Q	0.03
SILVER						
Batopilas Mining	New York	⅜	⅛	⅛	Dec. '07, I	0.12½
Beaver Consol.	Toronto	47	43½	45½	May '20, K	0.03
Candelaria	N. Y. Curb	*23	*20	*21		
Coniagas	Toronto			2.15	May '21, Q	0.12½
Crown Reserve	Toronto	48⅛	47	48⅛	Jan. '17,	0.05
Hilltop-Nev.	N. Y. Curb.	1 1/16	1⅛	1⅛		
Kerr Lake	N. Y. Curb	3⅛	3	3⅛	Jan. '23, Q	0.12½
La Rose	Toronto	*36	*29	*29	Apr. '22,	0.10
McKinley-Dar.-Sav.	Toronto	*24⅛	*23	*23	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	2.38	2.10	2.10	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	6⅛	6	6⅛	Jan. '23, Q, X	0.60
Ontario Silver	New York	6½	6⅛	6½	Jan. '19, Q	0.50
Temiskaming	Toronto	*37	*34	*34	Jan. '20, K	0.04
Trethewey	Toronto	*5	*4⅛	*5	Jan. '19,	0.05

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York	⅛	⅛	⅛		
Alaska Juneau	New York	1⅛	1⅛	1⅛		
Atlas	Toronto	13	12	12		
Carson Hill	Boston	9⅛	8⅛	8⅛		
Cresson Consol. G.	N. Y. Curb	2⅛	2⅛	2⅛	Jan. '23 Q.	0 10
Dome Mines	New York	41⅛	41	41⅛	Jan. '23, Q	0 50
Golden Cycle	Colo. Springs	1.06	1.01⅛	1.06	Dec. '22, Q	0.02
Hollinger Consol.	Toronto	13.80	13.40	13.40	Feb. '23, M	0.05
Homestake Mining	New York	70	69⅛	70	Feb. '23, M	0.50
Keora	Toronto	*14	*13	*14		
Kirkland Lake	Toronto	*56⅛	*52	*52⅛		
Lake Shor e	Toronto	3.65	3.55	3.55	Nov. '22, Q	0.02
McIntyre- Porcupine	Toronto	19.75	19.25	19.35	Jan. '23, K	0.25
Porcupine Crown	Toronto	*14⅛	*14⅛	*14⅛	July '17,	0.03
Portland	Colo. Springs	*35	*18	*35	Oct. '20, Q	0.01
Schumacher	Toronto	*30	*29⅛	*29⅛		
Teck Hughes	Toronto	1.09	98	1.09		
Tom Reed	Los Angeles	1.20	1.15	1.15	Dec. '19,	0.02
United Eastern	N. Y. Curb	2⅛	2⅛	2 1/16	Jan. '23, Q	0.15
Vipond Cons.	Toronto			*75		
White Caps Mining	N. Y. Curb			*8		
Wright-Hargreaves	Toronto	3.70	3.30	3.70	Jan. '23,	0.02½
Yukon Gold	N. Y. Curb	*90	*85	*90	June '18,	0.02½
GOLD AND SILVER						
Boston-Mont. Corp.	N. Y. Curb	*13	*12	*13		
Cons. Virginia	San Francisco			*10⅛		
Continental Mines	N. Y. Curb	5⅛	5⅛	5⅛		
Dolores Esperanza	N. Y. Curb	2⅛	2	2⅛	Jan. '23	2.50
Tonopah Belmont	N. Y. Curb	1⅛	1⅛	1⅛	Jan. '23, Q	0.05
Tonopah Divide	N. Y. Curb	*74	*70	*73		
Tonopah Extension	N. Y. Curb	3 1/16	3 1/16	3 1/16	Jan. '23, Q	0.05
Tonopah Mining	N. Y. Curb	2⅛	2 1/16	2⅛	Jan. '23, SA,	0.15
West End Consol.	N. Y. Curb	1⅛	1 1/16	1⅛	Dec. '22, Q	0.05
SILVER-LEAD						
Caledonia Mng.	N. Y. Curb	*7	*6	*6	Jan. '21, M	0.01
Cardiff M. & M.	Salt Lake	*31	*31	*31	Dec. '20,	0.15
Chief Consol.	Boston Curb	5	4⅞	5	Feb. '23, Q	0.10
Columbus Rexall	Salt Lake	*26⅛	*20⅛	*26⅛	Aug. '22,	0.03
Consol. M. & S.	Montreal	30⅛	27⅛	29⅛	Oct. '20, Q	0.62½
Eagle & Blue Bell	Boston Curb	†3⅛	†2⅛	2⅛	Nov. '22, K	0.05
Federal M. & S.	New York			11	Jan. '09,	1.50
Federal M. & S. pfd.	New York	53⅛	52⅛	53⅛	Mar '23, Q	1.75
Florence Silver	Spokane	*38⅛	*38	*38	Apr. '19,	0.01½
Hecla Mining	N. Y. Curb	9	8⅛	9	Dec. '22, Q, X	0.50
Iron Blossom Con.	N. Y. Curb	*32	*31	*32	Apr. '22, Q	0.02½
Marsh Mines	N. Y. Curb	*9	*9	*9	June '21, I	0.02
Park City	Salt Lake			3.70	Jan. '23,	0.10
Prince Consol.	Salt Lake	*9⅛	*9⅛	*9⅛	Nov. '17,	0.02½
Silversmith	Spokane	*47	*45	*45	Oct. '22,	0.01
Simon Silver Lead	N. Y. Curb	*32	*30	*32		
Tamarack-Custer	Spokane	1.60	1.60	1.60	Jan. '21, K	0.04
Tintic Standard	Salt Lake	2.95	2.87½	2.95	Dec. '22, Q, X	0.10
Utah-Apex	Boston	4⅛	4	4⅛	Nov. '20, K	0.25
IRON						
Bethlehem Steel "B"	New York	70⅛	67⅛	68	Jan. '23	0.25
Char. Iron	Detroit	2 1/16	2 1/16	2 1/16		
Char. Iron, pfd.	Detroit			2⅛		
Colorado Fuel & Iron	New York	29⅛	28⅛	28⅛	May '21	0.75
Col. Fuel & Iron, pfd.	New York			102	Feb. '23 Q	2.00
Mt. North'n Iron Ore	New York	35	33	35	Dec. '22	1.00
Inland Steel	N. Y. Curb			47⅛	Mar. '23	0.25
Mesabi Iron	N. Y. Curb	10⅛	10⅛	10⅛		
Reologle Steel	New York	28⅛	27⅛	27⅛		
Republic I. & S.	New York	61⅛	60	60⅛	May '21	1.50
Republic I. S., pfd.	New York	96⅛	95⅛	95⅞	Jan. '22	1.75
Sloss-Sheffield S. & I.	New York	56⅛	52⅛	56	Feb. '21	1.50
U. S. Steel	New York	108⅛	107⅛	107⅛	Dec. '22	1.25
U. S. Steel, pfd.	New York	120	119	119	Feb. '23	1.75
Virginia I. C. & C.	New York	64	63⅛	64	Jan. '22	1.50
Virginia I.C.&C., pfd.	New York	84	84	84	Jan '23	2.50
VANADIUM						
Vanadium Corp.	New York	42⅛	41	41⅛	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp.	Montreal	71	68⅛	71	Oct. '22, Q	1.50
Asbestos Corp. pfd.	Montreal	91	89⅛	91	Oct. '22, Q	1.75
SULPHUR						
Freeport Texas	New York	20⅛	19⅛	20⅛	Nov. '19, Q	1.00
Texas Gulf	New York	62⅛	59⅛	61⅛	Mar. '23, Q	1.25
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	4	3⅛	3⅛		
MINING, SMELTING AND REFINING						
Amer. Metal	New York	55⅛	53⅛	53⅛	Mar. '23, Q	0.75
Amer. Metal pfd.	New York			115⅛	Mar. '23, Q	1.75
Amer. Sm. & Ref.	New York	66⅛	65⅛	65⅛	Mar. '21, Q	1.00
Amer. Sm.& Ref. pfd	New York	102	101⅛	102	Mar. '23 Q	1.75
U. S. Sm. R. & M.	New York	41⅛	41	41	Jan. '21, Q	0.50
U.S. Sm.R.& M. pfd.	New York	46	45⅛	46	Jan. '23 Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra.

Toronto quotations courtesy Arthur E. Moysey; Spokane, Pohlman Investment Co; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Mines and Oil; Colorado Springs, Colorado Springs Stock Exchange.

NEW MACHINERY AND INVENTIONS

The Electrochemical Machine and Process

A machine and process which, it is claimed, effects a saving in the cost of the production of gold from mining plants now using the established processes has recently been announced by the Electrochemical-Centrifugal Co., Drexel Building, Philadelphia, Pa. The results obtained by the machine are based on well-known physical, chemical, and electrical laws and, combined in a commercial operative unity, produce a facility for the recovery of the group of the precious metals.

The machine in its operation, is said to develop and utilize centrifugal, pressure, and electrochemical forces, and electrolysis, and by means of these forces properly applied and operating in the machine, the precious metals are entrained in the mercurial cathode in the machine and are also held, constantly being collected therein, while the silica and waste material are freely discharged from the machine.

The machine operates in the following manner: The flowing pulp in the form of ground sand or ore (ground to 80 mesh), carrying the values in the precious metals in a finely comminuted state, is passed under a pressure of about 10 lb. continuously through the machine, the water and ground ore in the pulp being in a flowing state with a large excess of water. As the pulp under pressure passes through the machine, the particles of the precious metals having ponderable weight are thrown by centrifugal force to a quicksilver cathode. At the same time an electric current of proper voltage and amperage is caused to pass from the anode to the cathode, through the flowing pulp, and this action accomplishes the following results: The finely comminuted metals that are floating in the electrolyte liquid or are in the form of minute suspensoids or dissolved therein are thrown into the cathode. These metals are immediately absorbed in the mercury cathode, and are amalgamated therewith. The mercury also, by the passing of the electric current into it, attracts the precious metals to a greater degree. It is a fact that quicksiler has no attractive affinity whatever for the platinum metals in its natural state, but that when activated by the passage of the electric current, as described and operating in this machine, quicksiler will attract and hold platinum.

These results are continuously and commercially obtained as long as the machine is operating. At certain periods depending upon the richness of the ore treated, the machine is stopped, the mercury falls to the base of the machine, and is quickly drawn off for distillation. All the quicksiler is thus recovered, there is no loss whatever in operation or distillation, and the precious metals are found as a residue in the retorts.

The electric current also prevents the flouring of the quicksilver and therefore obviates all loss of this metal in operation. It also overcomes and prevents the quicksilver from becoming "sick," as it is called, in which state quicksilver will not amalgamate gold.

The capacity of No. 1 standard machine, 12 inches in diameter, is said to be from three to five tons of ground ore per hour.

The machine is said to remove and recover the gold from solutions of cyanide of gold and other solutions carrying gold in solution. The cyanide of gold (which is an excellent electrolyte) is passed through the machine, and instantly concentrated by the centrifugal force against the mercurial cathode in the machine, as it passes into and through it. Simultaneously, the passage of a direct flow of electric current from the anode in the machine through the concentrated solution impressed against the mercurial wall constituting the cathode, causes a migration of the gold in the solution into the mercurial cathode.

Each unit occupies a space 4 ft. square, so that it is apparent that a large number of units can be readily installed and operated in a small space. A floor space of 50x25 ft. would give room for seventy machines, each with a capacity of fifty tons per day or an aggregate treatment of at least 3,500 tons of ore per day of twenty hours.

Unit-Type Oil Engine Facilitates Transportation

The perfecting of the marine type of Diesel engine has served to draw attention to a machine of modified design for stationary purposes. The Standard Gas Engine Co., of Oakland, Calif., has specialized in the construction of heavy-oil engines for twenty years, and is now marketing a variety of sizes, from 7½ to 300 hp., of one, two, three, four, or six cylinders. Aside from the advantage of a reliable source of power, using a fuel of universal availability, an important feature of the Frisco Standard engine, as it is called, is the ability to pack in units of comparatively small weight and to sectionalize the bedplate if necessary. This unit construction facilitates erection, insures unusual accessibility, and has the added advantage of maximum interchangeability of parts. The output of the one-cylinder engine varies from 7½ to 50 hp., according to the size of the cylinder; the output of the three-cylinder engine shown in the accompanying cut varies from 25 to 150 hp. Fuel consumption (crude or residual oil) is from 0.7 lb. per brake horsepower for the smaller sizes, to 0.6 lb. for the larger sizes.

The company is favorably situated in regard to transportation facilities, and is in a position to make prompt shipment on either domestic or foreign orders.

INDUSTRIAL NOTES

Henry H. Ashley, president of the Hazard Mfg. Co., of Wilkes-Barre, Pa., died on Jan. 20.

The Cleveland Rock Drill Co. has moved its Pacific Coast headquarters to 621 California St., Sacramento, Calif.

Norman Strugnell has been appointed representative of the Pure Carbon Co., Wellsville, N. Y., in northern West Virginia. His headquarters are at Clarksburg, W. Va.

The Cement Gun Co., Inc., announces the resignation of W. J. Roberts as president of the company and the election of B. C. Collier to fill the vacancy Mr. Collier has for several years occupied the position of vice-president and general manager of the company.

The Charter Gas Engine Co., Sterling, Ill., announces the purchase of the entire "Mietz" oil engine (also known as "Mietz and Weiss") business, heretofore carried on at 128-138 Mott St., and 430 East 19th St., New York City, by the August Mietz Corporation and the Reliance Oil Engine Corporation. This effects a merger and consolidation, under one management, of two of the oldest internal-combustion engines in the world.

The Th. Goldschmidt Corporation, 15 William St., New York, N. Y. has been established by the Th. Goldschmidt A. G. in Essen, which, years ago, also founded the Goldschmidt Detinning Co. and the Goldschmidt Thermit Corporation, now united in the Metal and Thermit Corporation. The Th. Goldschmidt Corporation represents the Th. Goldschmidt A. G. and its affiliated firms, the Chemische Fabrik Buckau A. G. of Magdeburg, Neufeldt & Kuhnke of Kiel and several other European concerns which have been established for the sale of their products and for the exploitation of new processes and apparatus in the United States and Canada. The president of the corporation is Dr. Franz Meyer, manager of the Th. Goldschmidt A. G., formerly director and officer of the Metallurgical Co. of America, a subsidiary of the American Metal Co. Ltd., and consulting engineer of the General Chemical Co.

TRADE CATALOGS

Ash Conveyors — Combustion Engineering Corporation, Broad St., New York, have recently issued a 12-p. pamphlet describing and illustrating their Combusco water seal ash conveyor. This is a distinctly new type of ash conveyor in this country, although a number of successful installations of it have been made in Europe by associated companies.